Application to the Representative Policy Board for Approval of a Project to Construct Route 80 Control Valve Improvements

South Central Connecticut Regional Water Authority
November 20, 2025
REVISED November 21, 2025 Per Authority Board Input

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1. Statement of Application

This application is presented by the South Central Connecticut Regional Water Authority (RWA) to the Representative Policy Board (RPB) of the South Central Connecticut Regional Water District for approval of the Route 80 Control Valve Improvements project. Section 19 of Special Act 77-98, as amended, requires the RPB approval before the RWA commences any capital project that will cost more than $3.5 million. The proposed project will cost approximately $9.9 million.

The existing Route 80 Control Valve, also referred to as the Route 80 Throttling Valve (Route 80 TV), is located in New Haven, within Foxon Boulevard (Route 80), proximate to the intersection of Quinnipiac Avenue. The Route 80 TV is a direct buried 36-inch gate valve, installed on a reduced diameter section of the 48-inch prestressed concrete cylinder pipe (PCCP) transmission main. The Route 80 TV works in parallel with the Essex Street Pressure Reducing Valve (PRV), providing a reduced hydraulic grade line for a portion of the New Haven Service Area, while sustaining the upstream grade line. The vault that houses the gate valve operator is located beneath one of the westbound lanes of Route 80, which requires traffic control for access and appropriate equipment to safely enter the confined space. Additionally, there is a 6-inch bypass pipe with an inline gate valve that provides for limited flow around the TV but does not allow for isolation of the TV for replacement or maintenance.

Furthermore, the existing TV is a gate valve, which is not ideal for controlling water flow and pressure. A gate valve is typically utilized as an isolation valve, either placed in a fully open or closed position. Gate valves can be challenging for throttling and pressure control applications, and this type of use can affect the proper operation of the valve. For example, the continuous flow and pressure against the partially open plate can cause issues with the metal plate over time and not allow the valve to seat properly. The existing gate valve is over 60 years old, and the risk of failure will continue to increase over time. To replace it in the event of a failure would entail a significant excavation in this major intersection that would be very costly due to the location and can cause significant disturbance. For these reasons, it is recommended that the Route 80 TV be replaced with a new control valve within a vault, in a safer, more accessible location outside of the Route 80 travel way.

In March 2022, a study was completed by Tighe & Bond to evaluate potential sites to locate a new valve vault and infrastructure to replace the functionality of the existing valve. A technical memorandum was prepared that identified two sites on the Ross Woodward School (Woodard School) property as being the most favorable locations and recommended that a globe style control valve be selected to replace the existing gate valve. Appendix A contains the Technical Memorandum that summarizes the site evaluation. Subsequent site visits by RWA staff, City of New Haven, and Board of Education officials resulted in consensus for the vault location at the eastern side of the school property, adjacent to the former Day's Inn motel.

In February 2025, the final easement was executed with the City of New Haven and City of New Haven Board of Education, providing use of the preferred site on the Woodward School property. The partnership with officials from the City of New Haven's Engineering's Department, Board of Education, and Woodward School was key to allowing the project to move forward.

In April 2024, field investigations and preliminary engineering were conducted at the Woodward School site. During progression of this work, several connection alternatives between the new vault and the existing Route 80 transmission main were evaluated, as memorialized in Appendix B. One of the alternatives evaluated was a connection to the vault via a new 36-inch ductile iron pipe (DIP) along Barnes Avenue. This alternative was favored in large part because it did not require a shutdown of the existing 48-inch PCCP transmission main.

While evaluating project alternatives, RWA was made aware of Connecticut Department of Transportation (CTDOT) and City of New Haven plans for roadway and pedestrian improvements in the immediate vicinity of the new vault site. The proposed connection point (tap) on the existing 48-inch PCCP transmission main is within Route 80 and directly within the CTDOTs proposed roadway and pedestrian improvements. As a result, constructing the connection prior to CTDOT and New Haven's roadway/sidewalk improvements became a priority. It was determined that the construction of the work on Route 80, continuing into the Woodward School site would progress sooner than the valve vault, as Phase 1 of the project. This was feasible for a few reasons: RWA had possession of one 36-inch gate valve that was compatible with the tapping sleeve, RWA obtained easement rights within the Woodward School site, and RWA was able to utilize their on-call water main contractor to complete the work. In the spring of 2025, RWA completed the Phase 1 work, which included the connection to the existing 48-inch main along Route 80 and installation of approximately 50 feet of 36-inch water main to the Woodard School site. Appendix C contains the draft Record Drawings of the work that was completed as part of Phase 1.

Tighe & Bond is now advancing the engineering design and cost estimation for the valve vault and interconnecting piping down Barnes Avenue (Phase 2). Appendices D and E contain the 50% complete design drawings and the Engineer's Opinion of Probable Cost for the Route 80 Control Valve Improvements – Phase 2 project, respectively.

This application provides detailed information, including a description of the project, an explanation of why it is necessary, a discussion of the alternatives considered, and the estimated cost of the construction to allow the RPB to make an informed decision on behalf of the RWA's customers and member communities.

2. Description of the Proposed Action

This project will include a new valve vault with control valve and associated utilities, paved access driveway, 36-inch ductile iron interconnecting piping and valving, relocation/replacement of an existing cast iron 12-inch distribution main, as well as other site improvements necessary for the construction of the valve vault.

The new valve vault is currently approximated to be 35-feet by 25-feet and will house a 36-inch control valve, 36-inch isolation butterfly valves, and a 30-inch bypass line. It will be located on the Woodward School site, within the easement obtained by the RWA. The existing Route 80 TV will remain live throughout the construction. After completion of the project, the existing Route 80 valve will be utilized as an isolation valve, as opposed to a throttling valve, to re-route flow into the new 36-inch main on Barnes Avenue.

The Phase 2 construction effort will extend the new 36-inch ductile iron pipe installed under Phase 1 to the new valve vault and then construct an additional approximately 1,100 feet of 36-inch pipe along Barnes Avenue to connect to a proposed tap on the existing 48-inch PCCP within Quinnipiac Avenue as shown in Figure 1. To provide space for the installation of the 36-inch transmission main in Barnes Avenue, coordination with existing utilities, including the potential relocation of the existing 12-inch cast iron distribution main within Barnes Avenue, will be required.

More specifically, the work consists of:

- Site Work
    - Clearing and grading of the site in preparation for precast concrete valve vault construction.
    - Soil and erosion control measures on the valve vault site and stormwater management systems to control site runoff.
    - Constructing a retaining wall and installation of the new driveway.
    - Installing permanent fencing around the perimeter of the easement.
    - Temporary and permanent site restoration efforts along Barnes Avenue and Quinnipiac Avenue.
    - Removing trees on Barnes Avenue to accommodate the installation of the new 36-inch transmission water main.
- Piping/Utilities

    - Installing approximately 1,100 linear feet of 36-inch ductile iron transmission main, hydrant blowoffs, and valving on Barnes Avenue.
    - Installing a 48-inch by 36-inch tapping sleeve and valve on the existing 48-inch PCCP transmission water main on Quinnipiac Avenue.
    - Relocating approximately 960 linear feet of existing 12-inch cast iron distribution water main with new 12-inch ductile iron distribution water main, new hydrant branches, valving, and portions of impacted services on Barnes Avenue.
    - Relocating or supporting sanitary sewer and/or stormwater utilities on Barnes Avenue to accommodate the installation of the new 36-inch transmission water main.

- Structural/Mechanical

    - Installing a new control valve vault including access and life safety equipment, sump pumps and environmental controls within the vault.
    - Installing a control valve, associated isolation valves, and piping to bypass the new control valve.

- Electrical

    - Providing a new electrical service from Barnes Avenue to the site.
    - Installing new electrical equipment to provide power to the new control valve vault, equipment, and site lighting.
    - Installing new SCADA communications equipment and intrusion detection from the new infrastructure to RWA's existing SCADA and security system.

Project Area Overview

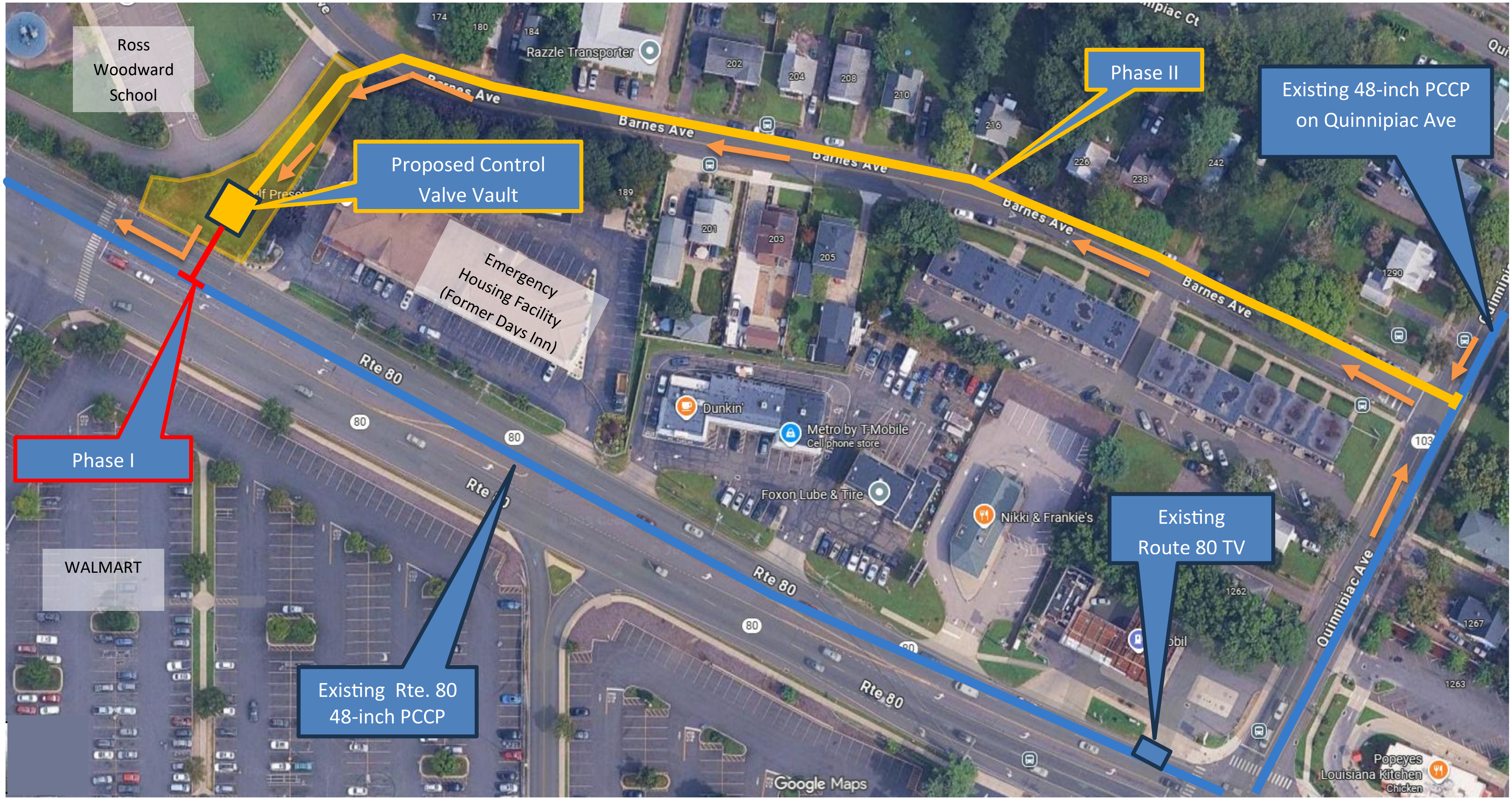

Figure 1

3. Need for the Proposed Action

The Route 80 TV is a critical piece of infrastructure within the RWA's water distribution system. The ability to move water within the New Haven Service Area, which accounts for approximately 40% of the overall distribution system flow and serves a population of approximately 189,000 people, is highly dependent on the concurrent operation of the Essex Street PRV and the Route 80 TV. The new Route 80 Control Valve will ensure the continued connection of these two facilities, but the additional, refined control of flow and pressure at Route 80 will also provide additional flexibility with the sources of supply to the service area. For example, the Lake Whitney Water Treatment Plant (LWWTP) has historically been limited to 5 MGD during the lower demand periods due to hydraulic restrictions in the system. With the additional functionality at the new Route 80 facility, hydraulic modeling has indicated that operators will have the flexibility to modify operations of the system to increase the flow from LWWTP, therefore decreasing the flow required from LGWTP and the amount of water withdrawn from Lake Gaillard during winter months. The new control valve will mitigate the risk of failure associated with the existing Route 80 TV, given its age and condition. Constructing the control valve vault outside of a Route 80 travel lane will provide for safer access and eliminate the need for traffic control. The new control valve vault also provides safer access and will not require confined space entries for the RWA personnel as is currently the case.

Specifically, it has been determined that this project is necessary based on the following reasons:

- Reliability: Remaining life expectancy of the existing Route 80 TV is questionable given its age and its current use. The risk of failure will continue to increase over time and sufficient valving does not exist to isolate the Route 80 TV for maintenance and repair. Furthermore, because the existing Route 80 TV is a gate valve, it is not well suited for its intended purpose of controlling water flow and pressure. Construction of the new control valve mitigates the existing risk of failure, providing reliable and improved control of water flow and pressure. Construction of the new control valve also provides a full bypass so that supply to the service areas is not interrupted for any future maintenance and repair.

- Additional Functionality: By replacing the functionality of the existing gate valve and 6-inch bypass with a new control valve and 30-inch bypass, operators will have more precise control over the flow and pressure in the New Haven Service Area, as well as the ability to conduct normal maintenance and repair on the infrastructure in a more efficient manner. The current valve makes adjustments challenging and less accurate. Utilizing the new valve in conjunction with the Essex Street PRV will now allow the operational flexibility to utilize flow from LWWTP and LGWTP more efficiently and easily make adjustments depending on distribution system demands. This will also allow operators to protect water supplies and sustainably utilize different sources during droughts. At present, flow measurement is not available for the Route 80 valve; however, the new control valve equipment will be designed to include flow rate calculation capabilities.

- Risk reduction: There are multiple risks associated with the current infrastructure. The risk of failure of the valve due to the age and manner of operation; risk to RWA personnel and traffic detail personnel during valve maintenance on a busy state roadway; and the risk to employees entering the confined space. All of these risks would be significantly mitigated with the proposed project. The new valve vault will be located outside of Route 80, the new vault will eliminate the confined space, and the new valve is designed for the intended purpose of controlling flow and pressure.

- Safety: Safety is a significant concern with the existing Route 80 TV. The vault is a confined space and is located in a very busy multi-lane state roadway, requiring additional manpower and equipment to access the valve. Accessing the existing Route 80 TV requires traffic control and a traffic management plan, with appropriate equipment to safely enter the confined space. The new valve vault will be located safely off the state road and is being designed so that it is not a confined space in normal operation.

4. Analysis of the Alternatives to the Proposed Action

In determining the best course of action to address the replacement of the existing Route 80 TV, RWA evaluated several alternatives. The alternatives included the no action approach, the Route 80 (Foxon Boulevard) piping connection, and the Barnes Avenue piping connection.

Alternative 1 – No Action: If no action is taken to replace the existing Route 80 TV, the risk of failure will continue to increase over time. An unplanned replacement of the valve would be very costly, create significant disturbance to Route 80 traffic patterns and substantially affect customers in part or all of the New Haven Service Area, depending on demands and valve position at the time of failure. Additionally, safety will remain a serious concern, requiring RWA personnel to enter a confined space in the middle of a multi-lane state roadway. Elimination of the control valve was also briefly evaluated; however, a control valve is required in this area to maintain pressures in upgradient areas that are closer to the Lake Gaillard Water Treatment Plant.

Alternative 2 – Route 80 (Foxon Boulevard) Piping Connection to New Valve Vault: This alternative included inlet and outlet connections to a new control valve vault from the existing 48-inch PCCP within Route 80. Constructing these piping connections and adding an inline isolation valve would require a complete and extended shut down of the existing 48-inch PCCP transmission main. This would also require significant excavation, thrust blocks within Route 80, and retrofit pipe restraint of the existing 48-inch Route 80 PCCP. A complete shutdown of the 48-inch PCCP and removal of sections of the existing 48-inch pipe would be higher risk during construction, due to system operational concerns and construction risks. Adding extensive pipe restraint to the existing 48-inch PCCP was also not favorable, given the age of the pipe, the significant excavation on Route 80, and the disturbance to the existing pipe that would create a potential for settlement and other structural and leakage issues. This would also entail restriction of the Route 80 pipe to low flow for an extended period, to accommodate pipe restraint activities.

Additionally, Alternative 2 would require extensive permitting, traffic control, and major disruption for an extended period on Route 80. Another detracting factor was the duration associated with this alternative to obtain CTDOT permits and the long lead times for the needed 36-inch and 48-inch tapping and isolation valves. The timeline to complete this alternative would have extended beyond the anticipated start dates of the CTDOT and City of New Haven roadway and pedestrian improvements located in the same area.

Alternative 3 – Barnes Avenue Piping Connection to New Valve Vault: This alternative includes tapping the existing 48-inch PCCP on Quinnipiac Avenue and installing a 36-inch pipe on Barnes Avenue to a new control valve structure located on the Woodward School easement. The 36-inch pipe would then be extended to a tap located on the existing Route 80 PCCP transmission main. Connecting to the 48-inch pipe on Quinnipiac Avenue requires a 48-inch by 36-inch tapping sleeve and 36-inch valve. This can be conducted as a live tap without a complete shutdown of the existing 48-inch PCCP transmission main. Upon completion of this work, the existing Route 80 TV can be closed and flow diverted up Quinnipiac Avenue, down Barnes Avenue, through the valve vault, and back to the transmission main on Route 80. Due to the existing utilities that are located within Barnes Avenue, this alternative will require several utilities to be relocated and supported.

Recommendation – Alternative 3 is most favorable in terms of added functionality, improving safety, and mitigation of construction related risks. This alternative to add a 36-inch pipe on Barnes Ave and move the control valve to the easement property was selected for the following major reasons:

- Alternative 2 would require a significant amount of disruption to traffic on Route 80 and much more disruption of the existing 48-inch PCCP. The City of New Haven and CTDOT projects, would make this project less feasible, traffic management problematic, and more costly.

- Alternative 3 provides the same flow and pressure control for the Route 80 transmission main as Alternative 2, while minimizing risk and operational concerns during both construction and longterm.

- Alternative 3 was constructable in a timeframe that was consistent with the City of New Haven and CTDOT projects. The Phase 1 construction could be expedited and implemented by RWA to facilitate Alternative 3.

The development of Alternatives 2 and 3 are discussed in further detail in the Route 80 Throttling Valve Project Preliminary Design Alternatives Technical Memorandum, included in Appendix B.

With Alternative 3 being identified as RWA's preferred option, RWA implemented an expedited Phase 1 construction program to accommodate the City of New Haven and CTDOT's schedule. RWA constructed the outlet connection (Phase 1), utilizing the one 36-inch tapping valve that RWA had in stock and completed the work with an on-call contractor. Without this swift action, this project would have been much more difficult to complete within RWA's schedule.

4.1 Business Case Evaluation

A Business Case Evaluation (BCE) was performed by RWA to compare and evaluate the alternatives above and is included in Appendix F. The BCE was conducted using the comprehensive Triple Bottom Line (TBL) approach, that evaluates life-cycle costs, cost-benefit ratio, and risk & social factors (including environmental) to determine the best long-term solution to a problem. The following summarizes the results of the BCE.

- Life Cycle Cost Projection (LCCP): The Life Cycle Costs Annuitized Cost Stream is the least for Alternative 3 at $445,000 compared to $466,000 for Alternative 2.
- Risk Reduction: The Risk Reduction Effectiveness Factor is the highest for Alternative 3. Both of the alternatives were evaluated to reduce the Risk Cost from the Status Quo, with the Barnes Avenue Alternative being the most impactful. The Risk Cost (annual basis) of the Status Quo is about $4.1 million. The overall Residual Risk Cost (annual basis) is about $1.5 million for Alternatives 2 and approximately $41,000 for Alternative 3.
- Benefit/Cost: The Benefit/Cost Ratio is a ratio of the benefit value over the cost value. A higher result demonstrates that the project is more cost effective than the other alternatives for the benefits it delivers. This calculation allows for the quantification of factors such as environmental and social impact of a project (both during construction and long-term). The Benefit/Cost Ratio is highest for Alternative 3, with a result of 12.62; followed by Alternative 2, with a much lower result of 7.83.

Based on the results of the BCE, Alternative 3, Barnes Ave Piping Connection to New Valve Vault was determined to best address all aspects of the need for proposed action.

5. Statement of the Cost to Be Incurred and/or Saved

5.1 Capital Cost

This project will result in a capital expenditure of $9.9 million. A high-level breakdown of the capital cost for this project is presented in Table 1. A detailed breakdown of this cost estimate is contained in Appendix E. The project costs presented are based on 50% complete design drawings, prepared in August 2025. In accordance with cost estimating principles, the project costs have been adjusted for inflation.

TABLE 1
Estimated Project Capital Cost

Description	Estimated Cost
Previous Expenditures (through October 2025) (inclusive of Phase I construction)	$1,315,716
Consultant Engineering Fees	
Final Design	$156,700
Construction Administration/Observation	$585,000
Construction	$6,260,000
10% Construction Contingency	$626,000
Inflation – 3% per year to midpoint of construction	$420,000
RWA Costs - Project Management, Permitting, SCADA Programming, Department Coordination	$540,000
Total Project Costs	$9,903,416
Rounded Total	$9,900,000

For the construction cost estimate, a 10% contingency is included. This is consistent with the American Association of Cost Engineers (AACE) International Recommended Practices and Standards (included in Appendix G) for a Class 2 estimate. In a Class 2 estimate, the design of the project is expected to be between 30% to 75% complete and accurate within -5% to +20%. The AACE defines contingency as a specific provision for unforeseeable elements of cost within the defined project scope, particularly where experience has shown that unforeseeable costs are likely to occur. Given that investigative test pits relative to existing utilities have not yet been completed for areas of Quinnipiac Avenue and Barnes Avenue, we believe this is prudent. Also, the 10% contingency allowance is included at this design stage for uncertainty in bid prices due to cost escalation and to reduce the risk of possible cost overruns. This project includes an inflation value of 3% per year to the midpoint of construction and construction costs are based on an ENR Construction Cost Index of 13913.52 from August 2025.

5.2 Operation and Maintenance Cost

This project will slightly increase operation and maintenance expenditures. The new vault will follow RWA standards and will include safety equipment and lighting, as well as dehumidification to prolong the life of equipment within the vault. The vault will require periodic maintenance of valves as well as site maintenance. However, there will also be savings due to reduced crew size during maintenance events and elimination of New Haven Police traffic management during maintenance. These changes in O&M costs would be the same for any alternative that installs the valve outside of the state road. The estimated increase in annual operation and maintenance expenditures due to these activities is $1,400.

5.3 Bonds or Other Obligations the RWA Intends to Issue

The annual cost of this project to a typical residential customer using 5 ccf's a month, assuming a conservative financing assumption of RWA Bonds, would be approximately $2.59, based on the project cost of $9.9 million. For a residential customer using 8 ccf's a month, the annual cost of this project would be approximately $3.51.

We expect to fund this project from a combination of sources. This project has been submitted for funding under the Connecticut Department of Public Health's (CTDPH) Drinking Water State Revolving Fund (DWSRF). This project appears on the comprehensive listing in CTDPH's SFY2026 DWSRF Annual Intended Use Plan and we have requested that this project be re-prioritized. By utilizing this funding source for construction, the total financing costs associated with this project will be reduced.

6. Preliminary Project Schedule and Permitting

6.1 Schedule

The project schedule is presented below.

1.	Preliminary Design:	August 2025
2.	90% Design	October 2025
3.	DPH Permitting	November 2025 – February 2026
4.	RPB Submission & Approval	November 2025 – February 2026
5.	Final Design	February 2026
6.	Bidding	February – May 2026
7.	Award	May 2026
8.	Active Construction	June 2026 to March 2028
9.	Start-up, Optimization, and Completion	March 2028

Construction on this project is expected to occur from June 2026 to March 2028, with the new control valve vault operational around March 2028. The active construction does not commence for approximately 6 months after the award due to the long manufacturing lead times associated with the control valve, precast concrete vault, large diameter valves, and the tapping sleeve and valve.

6.2 Permitting

This project involves the addition of a new control valve vault and associated appurtenances with interconnecting piping and sitework. The project will require the following permit approvals:

- Connecticut Department of Public Health (CTDPH):
  - Public Water System General Application for Approval or Permit
  - Water Main Application
- Connecticut Department of Transportation (CTDOT):
  - Encroachment Permit
- City of New Haven Local Permitting
  - Obstruction Permit including submitting preliminary design drawings to the City of New Haven City Plan Department, Engineering Department, Transportation, Traffic and

Parking Department, and City Parks and Public Works Department for comments and coordination of City infrastructure and Street Trees that may be affected by the project.

- Natural Diversity Database (NDDB) - NDDB filing to the Connecticut Department of Energy & Environmental Protection
- National Environmental Policy Act (NEPA) - Complete a National Environmental Policy Act (NEPA) compliance review if the project receives federal funding.

7. Statement of the Facts on Which the Board Is Expected to Rely in Granting the Authorization Sought

- The proposed project provides the operational flexibility, reliability and capacity to accurately control the flow and pressure to the New Haven Service Area.
- The proposed project mitigates a serious risk to RWA personnel and the public by eliminating access to critical infrastructure within a busy, traffic-filled state road.
- This project also provides a significantly safer and more efficient means of operating and maintaining the Route 80 control valve, by eliminating the confined space.

8. Explanation of Unusual Circumstances Involved in the Application

This project presented unusual circumstances regarding the sequencing of construction and expenditures. Initially, RWA planned to bid and complete the project in a single phase. The CTDOT and City of New Haven's Route 80 improvements project, however, required division of the work into two separate phases. Had RWA been unable to connect to the existing main before the Route 80 project commenced, securing a permit to excavate in newly paved areas would likely not have been possible for several years. Additionally, the revised road layouts and pedestrian landings would be problematic for traffic management.

By collaborating with Tighe & Bond to finalize the Phase I design, strategically utilizing materials in stock, securing an easement at Woodward School, and constructing the complex connection ahead of the CTDOT/City of New Haven project, RWA ensured both cost-effectiveness and a streamlined process for completing Phase 2. This did however cause a significant spend to date, as shown in Table 1.

9. Conclusion

The existing Route 80 TV is a critical component for controlling flow and pressure to the New Haven Service Area, while sustaining the upstream pressures for the other service areas in the water distribution system. Due to the CTDOT and City of New Haven plan for roadway and sidewalk improvements, the first phase of work was completed swiftly and efficiently. Phase 2 of the proposed Route 80 Control Valve Improvements provide the necessary upgrades to the existing control valve, mitigates multiple safety hazards related to traffic and confined space, and ensures consistent and reliable domestic water and firefighting supply to the New Haven Service Area for the foreseeable future. Without these improvements, the costs to operate and maintain this infrastructure will continue to increase, as will the risk of a failure or an emergency situation due to the inability to isolate or access the existing Route 80 TV for repair or replacement.

At $9.9 million, the project maximizes the cost and non-cost benefits for the RWA. As such, the RWA has concluded that the proposed action is consistent with and advances the policies and goals of the South Central Connecticut Regional Water Authority.

Appendix E

Route 80 Control Valve Improvements – Phase 2

Engineer’s Opinion of Probable Cost

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST Tighe&Bond

Project: Route 80 Control Valve Improvements - Phase 2 (Barnes Avenue and Vault)
Location: New Haven, CT
Component:

Estimate Type: ☐ Conceptual ☐ Preliminary Design ☑ Design Development @ 50 % Complete ☐ Construction ☐ Change Order

Prepared By: RB/HB/SC/AW
Date Prepared: 8/27/2025
T&B Project No.: S1889-A28A

Spec. Section	Item No.	Description	Qty	Units	Material/Installed Cost $/Unit	Material/Installed Cost Total	Installation $/Unit	Installation Total	Total
DIVISION 1 - GENERAL CONDITIONS			(Costs included in unit prices in other Divisions)						
		10% - Mobilization & Demobilization	1	LS	$495,260	$495,260		$0	$495,260
SUBTOTAL - DIVISION 1						**$495,260**		**$0**	**$495,260**
DIVISION 2 - SITE WORK									
		Test Pits	2	EA	$2,000	$4,000			$4,000
02220		Demolition							
		Cut Bituminous Concrete Pavement	3,750	LF	$10	$37,500			$37,500
		Tree Removal	5	EA	$5,000	$25,000			$25,000
		Remove and Reset Stairs	1	EA			$1,500	$1,500	$1,500
		Remove and Reset existing Guardrail	1	LF			$100	$100	$100
		Remove and Reset Catch Basin	1	EA			$5,000	$5,000	$5,000
		Remove and Rest Stone Curb	50	LF			$100	$5,000	$5,000
		Remove and Reset Sign	2	EA	$100	$200			$200
		Misc. Demo	1	LS	$10,000	$10,000			$10,000
02230		Clearing and grubbing		LS	$10,000	$0			$0
02270		Soil Erosion and Sediment Control	1	LS	$10,000	$10,000			$10,000
02280		Pipeline Abandonment	55	LF	$0	$0	$200	$11,000	$11,000
02315		Excavation, Backfill, Compaction and Dewatering							
		Pipelines	6,200	CY	$50	$310,000			$310,000
		Valve Vault Excavation	1,190	CY	$50	$59,500			$59,500
		Valve Vault Backfill	625	CY	$75	$46,875			$46,875
		Rock excavation (10% of earth excavation)	310	CY	$200	$62,000			$62,000
		Dewatering	1	LS	$28,000	$28,000			$28,000
		Sheeting & Bracing	1	LS	$92,000	$92,000			$92,000
02317		Underground Warning Tape	2,060	LF	$2	$4,120			$4,120
02320		Borrow Material							
		Water Main Bedding material	147	CY	$40	$5,880			$5,880
		Gravel Drive Repair - Service Repairs	10	SY	$30	$300			$300
		Gravel Drive Repair - Water Main Trench	10	SY	$30	$300			$300
02514		Ductile Iron Pipe and Fittings							
		36" DI Water Main	1,100	LF	$500	$550,000			$550,000
		36" 22 Bend	3	EA	$8,200	$24,600	$3,280	$9,840	$34,440
		36" 11 Bend	6	EA	$8,500	$51,000	$3,400	$20,400	$71,400
		36" 45 Bend	1	EA	$9,700	$9,700	$3,880	$3,880	$13,580
		36" MegaLug Restraints	20	EA	$1,662	$33,240	$665	$13,296	$46,536
		12" DI Water Main	960	LF	$250	$240,000			$240,000
		12" MegaLug Restraints	20	EA	$1,800	$36,000	$720	$14,400	$50,400
		12" 22 Bend	2	EA	$1,100	$2,200	$440	$880	$3,080
		12" 11 Bend	4	EA	$1,000	$4,000	$400	$1,600	$5,600
		12" 45 Bend	4	EA	$1,300	$5,200	$520	$2,080	$7,280
02518		Valves and Hydrants							
		36" Tapping Gate Valve	1	EA	$96,250	$96,250			$96,250
		48" x 36" Tapping Sleeve	1	EA	$67,400	$67,400			$67,400
		Replace Hydrant Branch on Existing 12"	1	EA	$9,000	$9,000			$9,000
		12" Gate Valve	2	EA	$4,500				
		Flushing hydrants on new 36" Water Main	3	EA	$5,000	$15,000			$15,000
02519		Water Services							
		1" copper Pipe (type K)	550	LF	$25	$13,750			$13,750
		Re-connect Service	21	EA	$2,000	$42,000			$42,000
02530		Manholes and Catch Basins	5	EA	$5,000	$25,000			$25,000
02532		Stormwater Management							
		Yard Drain	2	EA	$1,200	$2,400			$2,400
		6" PVC	200	LF	$25	$5,000			$5,000
		12" HDPE	50	LF	$50	$2,500			$2,500
		Rain Garden	800	SF	$45	$36,000			$36,000
02740		Bituminous Concrete Pavement							
		Pavement for new Rt.80 TV site (driveway and parking area)	37	TON	$200	$7,400			$7,400
		Temporary pavement repair for Rt. 103 (Quinnipiac)	56	TON	$200	$11,200			$11,200
		Permanent pavement repair for Rt.103 (Quinnipiac)	73	TON	$200	$14,600			$14,600
		Temporary pavement repair for Barnes Avenue - 36" Water Main	266	TON	$200	$53,200			$53,200
		Temporary pavement repair for Barnes Avenue - 12" Water Main	119	TON	$200	$23,800			$23,800
		Temporary Pavement Repair for Barnes Avenue - Water Services	20	TON	$200	$4,000			$4,000
		Permanent pavement repair for Barnes Avenue	748	TON	$200	$149,600			$149,600
		Driveway apron replacement	11	TON	$200	$2,200			$2,200
		Bituminous speed hump repair	1	LS	$5,000	$5,000			$5,000
		Bollards	4	EA	$1,000	$4,000			$4,000
02760		Pavement Markings							
		4" Wide Markings (Yellow or White)	3,600	LF	$5	$18,000			$18,000
		12" Wide Markings	100	LF	$15	$1,500			$1,500
		Symbols and Legends Markings	100	SF	$20	$2,000			$2,000
02772		Bituminous Concrete Berm							
		Concrete Berm	0	LF	$40	$0			$0

02820		Chain Link Fence and Gate							
		Temporary Chain Link Fence	300	LF	$35	$10,500			$10,500
02823		Ornamental Metal Fence and Gates							
		6" High Ornamental Fence - School Property	210	LF	$100	$21,000			$21,000
		Swing gate manual, double	1	EA	$3,000	$3,000			$3,000
		Swing gate manual, single	1	EA	$1,500	$1,500			$1,500
02920		Loam and Seed							
		Loam and Seed - 36" Water Main Barnes Ave	35	SY	$10	$350			$350
		Loam and Seed - 36" Water Main School Lawn	150	SY	$10	$1,500			$1,500
		Loam and Seed - Water Services	35	SY	$10	$350			$350
01550		Traffic Control							
		Uniform Police Officer	430	HR	$150	$64,500			$64,500
		Traffic Control	1	LS	$100,000	$100,000			$100,000
		Utility Relocation Allowance (to relocate conflicting utilities)	1	LS	$200,000	$200,000			$200,000
		Concrete Retaining Wall	120	LF	$300	$36,000			$36,000
SUBTOTAL - DIVISION 2						**$2,701,115**		**$88,976**	**$2,790,091**

DIVISION 3 - CONCRETE									
03300		Cast-in-Place Concrete							
		Concrete Sidewalk	2	CY	$1,000	$2,000			$2,000
		Concrete Sidewalk - Water Service Restoration	20	CY	$1,000	$20,000			$20,000
		Concrete Curbs - Water Service Restoration	10	LF	$60	$600			$600
		Concrete Curbs - Water Main	30	LF	$60	$1,800			$1,800
		Concrete Apron	3	CY	$1,000	$3,000			$3,000
		Concrete Pad (for electrical / controls)	3	CY	$1,000	$3,000			$3,000
		Concrete Pad for Tapping Valve (15'x6')	7	CY	$1,000	$6,500			$6,500
		Misc.	1	CY	$1,000	$1,000			$1,000
		Concrete walkways	5	CY	$1,000	$5,000			$5,000
		Concrete Drive Repair	20	CY	$1,000	$20,000			$20,000
		Thrust Blocks	89	CY	$1,000	$89,000			$89,000
		Tapping & Buried Valve Support Blocks	2	CY	$1,000	$2,000			$2,000
03485		Precast Concrete Structures							
		Rt.80 TV Vault (34'x24'x15') and Stair Vault (17'x4'x15')	1	EA	$1,279,000	$1,279,000	$122,250	$122,250	$1,401,250
SUBTOTAL - DIVISION 3						**$1,432,900**		**$122,250**	**$1,555,150**
DIVISION 4 - MASONRY/BUILDINGS									
SUBTOTAL - DIVISION 4						**$0**		**$0**	**$0**
DIVISION 5 - METALS									
SUBTOTAL - DIVISION 5						**$0**		**$0**	**$0**
DIVISION 6 - WOOD & PLASTICS									
SUBTOTAL - DIVISION 6						**$0**		**$0**	**$0**
DIVISION 7 - THERMAL & MOISTURE PROTECTION									
SUBTOTAL - DIVISION 7						**$0**		**$0**	**$0**
DIVISION 8 - DOORS & WINDOWS									
SUBTOTAL - DIVISION 8						**$0**		**$0**	**$0**
DIVISION 9 - FINISHES									
SUBTOTAL - DIVISION 9						**$0**		**$0**	**$0**
DIVISION 10 - SPECIALTIES									
10440		Signage	1	LS	$1,500	$1,500			$1,500
10522		Fire Extinguishers and Accessories	1	LS	$1,000	$1,000			$1,000
SUBTOTAL - DIVISION 10						**$2,500**		**$0**	**$2,500**

DIVISION 11 - EQUIPMENT									
11000		36" Control Valve and controls	1	LS	$326,000	$326,000	$25,000	$25,000	$351,000
SUBTOTAL - DIVISION 11						**$326,000**		**$25,000**	**$351,000**
DIVISION 12 - FURNISHINGS									
SUBTOTAL - DIVISION 12						**$0**		**$0**	**$0**
DIVISION 13 - SPECIAL CONSTRUCTION									
13420		Instrumentation							
		Pressure Transmitters	2	EA	$5,000	$10,000	$2,000	$4,000	$14,000
13461		SCADA System Improvements							
		Integrate New Equipment into Existing SCADA system	1	LS	$10,000	$10,000			$10,000
13860		Intrusion Detection Systems	1	LS	$5,000	$5,000			$5,000
SUBTOTAL - DIVISION 13						**$25,000**		**$4,000**	**$29,000**
DIVISION 14 - CONVEYING SYSTEMS									
SUBTOTAL - DIVISION 14						**$0**		**$0**	**$0**
DIVISION 15 - MECHANICAL									
		Building HVAC:							
15935		Controls	6	EA	$1,500	$9,000	$500	$1,500	$10,500
15950		Testing, Adjusting & Balancing	1	LS	$0	$0	$4,200	$4,200	$4,200
		Process:							
15125		Meters and Gauges - Pressure Gauges	3	EA	$500	$1,500	$200	$600	$2,100
SUBTOTAL - DIVISION 15						**$10,500**		**$6,300**	**$16,800**
DIVISION 16 - ELECTRICAL									
		Electrical Service - Single Phase	1	LS	$36,000	$36,000		$0	$36,000
		SS Electrical Cabinet, DP, & Misc. enclosures	1	LS	$52,000	$52,000		$0	$52,000
		Electrical Equipment	1	LS	$38,000	$38,000		$0	$38,000
		Misc. Wiring & Conduit	1	LS	$77,000	$77,000		$0	$77,000
		Site Lighting	1	LS	$5,000	$5,000		$0	$5,000
SUBTOTAL - DIVISION 16						**$208,000**		**$0**	**$208,000**
Total OPCC									**$5,447,801**

SUBTOTAL			$5,447,801
CONTRACTOR OH & P	15%		$817,170
CONSTRUCTION SUBTOTAL			**$6,264,971**
		SAY	***$6,260,000***
CONTINGENCY	20%		$1,250,000
CONSTRUCTION TOTAL			**$7,510,000**
ESCALATION TO MID-POINT OF CONSTRUCTION	3% / Yr		$460,000
CONSTRUCTION TOTAL (WITH ESCALATION TO MID-POINT OF CONSTRUCTION)			**$7,970,000**
ENGINEERING - DESIGN	Actual Amount		$590,200
ENGINEERING - CONSTRUCTION	12%		$960,000
ENGINEERING TOTAL			**$1,550,000**
PROJECT TOTAL			**$9,520,000**

Note: This is an Engineer's Opinion of Probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of probable construction cost.

Appendix G

American Association of Cost Engineers (AACE) Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries, August 2020

AACE INTERNATIONAL RECOMMENDED PRACTICE

18R-97

COST ESTIMATE CLASSIFICATION SYSTEM - AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES

AACE

INTERNATIONAL

AACE INTERNATIONAL

AACE International Recommended Practice No. 18R-97

COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES

TCM Framework: 7.3 – Cost Estimating and Budgeting

Rev. August 7, 2020

Note: As AACE International Recommended Practices evolve over time, please refer to web.aacei.org for the latest revisions.

Any terms found in AACE Recommended Practice 10S-90, *Cost Engineering Terminology*, supersede terms defined in other AACE work products, including but not limited to, other recommended practices, the *Total Cost Management Framework*, and *Skills & Knowledge of Cost Engineering*.

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COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES

TCM Framework: 7.3 – Cost Estimating and Budgeting

August 7, 2020

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1. PURPOSE

As a recommended practice (RP) of AACE International, the *Cost Estimate Classification System* provides guidelines for applying the general principles of estimate classification to project cost estimates (i.e., cost estimates that are used to evaluate, approve, and/or fund projects). The *Cost Estimate Classification System* maps the phases and stages of project cost estimating together with a generic project scope definition maturity and quality matrix, which can be applied across a wide variety of industries and scope content.

This recommended practice provides guidelines for applying the principles of estimate classification specifically to project estimates for engineering, procurement, and construction (EPC) work for the process industries. It supplements the generic cost estimate classification RP 17R-97[1] by providing:

- A section that further defines classification concepts as they apply to the process industries.
- A chart that maps the extent and maturity of estimate input information (project definition deliverables) against the class of estimate.

As with the generic RP, the intent of this document is to improve communications among all the stakeholders involved with preparing, evaluating, and using project cost estimates specifically for the process industries.

The overall purpose of this recommended practice is to provide the process industry with a project definition deliverable maturity matrix that is not provided in 17R-97. It also provides an approximate representation of the relationship of specific design input data and design deliverable maturity to the estimate accuracy and methodology used to produce the cost estimate. The estimate accuracy range is driven by many other variables and risks, so the maturity and quality of the scope definition available at the time of the estimate is not the sole determinate of accuracy; risk analysis is required for that purpose.

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This document is intended to provide a guideline, not a standard. It is understood that each enterprise may have its own project and estimating processes, terminology, and may classify estimates in other ways. This guideline provides a generic and generally acceptable classification system for the process industries that can be used as a basis to compare against. This recommended practice should allow each user to better assess, define, and communicate their own processes and standards in the light of generally-accepted cost engineering practice.

2. INTRODUCTION

For the purposes of this document, the term *process industries* is assumed to include firms involved with the manufacturing and production of chemicals, petrochemicals, and hydrocarbon processing. The common thread among these industries (for the purpose of estimate classification) is their reliance on process flow diagrams (PFDs), piping and instrument diagrams (P&IDs), and electrical one-line drawings as primary scope defining documents. These documents are key deliverables in determining the degree of project definition, and thus the extent and maturity of estimate input information. This RP applies to a variety of project delivery methods such as traditional design-bid-build (DBB), design-build (DB), construction management for fee (CM-fee), construction management at risk (CM-at risk), and private-public partnerships (PPP) contracting methods.

Estimates for process facilities center on mechanical and chemical process equipment, and they have significant amounts of piping, instrumentation, and process controls involved. As such, this recommended practice may apply to portions of other industries, such as pharmaceutical, utility, water treatment, metallurgical, converting, and similar industries.

Most plants also have significant electrical power equipment (e.g., transformers, switchgear, etc.) associated with them. As such, this RP also applies to electrical substation projects, either associated with the process plant, as part of power transmission or distribution infrastructure, or supporting the power needs of other facilities. This RP excludes power generating facilities and high-voltage transmission.

This RP specifically does not address cost estimate classification in non-process industries such as commercial building construction, environmental remediation, transportation infrastructure, hydropower, "dry" processes such as assembly and manufacturing, "soft asset" production such as software development, and similar industries. It also does not specifically address estimates for the exploration, production, or transportation of mining or hydrocarbon materials, although it may apply to some of the intermediate processing steps in these systems.

The cost estimates covered by this RP are for engineering, procurement, and construction (EPC) work only. It does not cover estimates for the products manufactured by the process facilities, or for research and development work in support of the process industries. This guideline does not cover the significant building construction that may be a part of process plants.

This guideline reflects generally-accepted cost engineering practices. This recommended practice was based upon the practices of a wide range of companies in the process industries from around the world, as well as published references and standards. Company and public standards were solicited and reviewed, and the practices were found to have significant commonalities. [4,5,6,7] These classifications are also supported by empirical process industry research of systemic risks and their correlation with cost growth and schedule slip [8].

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3. COST ESTIMATE CLASSIFICATION MATRIX FOR THE PROCESS INDUSTRIES

A purpose of cost estimate classification is to align the estimating process with project stage-gate scope development and decision-making processes.

Table 1 provides a summary of the characteristics of the five estimate classes. The maturity level of project definition is the sole determining (i.e., primary) characteristic of class. In Table 1, the maturity is roughly indicated by a percentage of complete definition; however, it is the maturity of the defining deliverables that is the determinant, not the percent. The other characteristics are secondary and are generally correlated with the maturity level of project definition deliverables, as discussed in the generic RP [1]. The specific deliverables, and their maturity or status are provided in Table 3. The post sanction (post funding authorization) classes (Class 1 and 2) are only indirectly covered where new funding is indicated. Again, the characteristics are typical but may vary depending on the circumstances.

	Primary Characteristic	***Secondary Characteristic***		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges at an 80% confidence interval
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Table 1 – Cost Estimate Classification Matrix for Process Industries

This matrix and guideline outline an estimate classification system that is specific to the process industries. Refer to Recommended Practice 17R-97 [1] for a general matrix that is non-industry specific, or to other cost estimate classification RPs for guidelines that will provide more detailed information for application in other specific industries. These will provide additional information, particularly the *Estimate Input Checklist and Maturity Matrix* which determines the class in those industries. See Professional Guidance Document 01, *Guide to Cost Estimate Classification.* [16]

Table 1 illustrates typical ranges of accuracy ranges that are associated with the process industries. The +/- value represents typical percentage variation at an 80% confidence interval of actual costs from the cost estimate after application of appropriate contingency (typically to achieve a 50% probability of project cost overrun versus underrun) for given scope. Depending on the technical and project deliverables (and other variables) and risks associated with each estimate, the accuracy range for any particular estimate is expected to fall into the ranges identified. However, this does not preclude a specific actual project result from falling outside of the indicated range of ranges identified in Table 1. In fact, research indicates that for weak project systems and complex or otherwise risky projects, the high ranges may be two to three times the high range indicated in Table 1. [17]

In addition to the degree of project definition, estimate accuracy is also driven by other systemic risks such as:

- Level of familiarity with technology.
- Unique/remote nature of project locations and conditions and the availability of reference data for those.
- Complexity of the project and its execution.
- Quality of reference cost estimating data.
- Quality of assumptions used in preparing the estimate.
- Experience and skill level of the estimator.
- Estimating techniques employed.
- Time and level of effort budgeted to prepare the estimate.
- Market and pricing conditions.
- Currency exchange.
- The accuracy of the composition of the input and output process streams.

Systemic risks such as these are often the primary driver of accuracy, especially during the early stages of project definition. As project definition progresses, project-specific risks (e.g. risk events and conditions) become more prevalent and also drive the accuracy range. Another concern in estimates is potential organizational pressure for a predetermined value that may result in a biased estimate. The goal should be to have an unbiased and objective estimate both for the base cost and for contingency. The stated estimate ranges are dependent on this premise and a realistic view of the project. Failure to appropriately address systemic risks (e.g. technical complexity) during the risk analysis process, impacts the resulting probability distribution of the estimated costs, and therefore the interpretation of estimate accuracy.

Figure 1 illustrates the general relationship trend between estimate accuracy and the estimate classes (corresponding with the maturity level of project definition). Depending upon the technical complexity of the project, the availability of appropriate cost reference information, the degree of project definition, and the inclusion of appropriate contingency determination, a typical Class 5 estimate for a process industry project may have an accuracy range as broad as -50% to +100%, or as narrow as -20% to +30%. However, note that this is dependent upon the contingency included in the estimate appropriately quantifying the uncertainty and risks associated with the cost estimate. Refer to Table 1 for the accuracy ranges conceptually illustrated in Figure 1. [18]

Figure 1 also illustrates that the estimating accuracy ranges overlap the estimate classes. There are cases where a Class 5 estimate for a particular project may be as accurate as a Class 3 estimate for a different project. For example, similar accuracy ranges may occur if the Class 5 estimate of one project that is based on a repeat project with good cost history and data and, whereas the Class 3 estimate for another is for a project involving new technology. It is for this reason that Table 1 provides ranges of accuracy values. This allows consideration of the specific circumstances inherent in a project and an industry sector to provide realistic estimate class accuracy range percentages. While a target range may be expected for a particular estimate, the accuracy range should always be determined through risk analysis of the specific project and should never be pre-determined. AACE has recommended practices that address contingency determination and risk analysis methods. [19]

If contingency has been addressed appropriately approximately 80% of projects should fall within the ranges shown in Figure 1. However, this does not preclude a specific actual project result from falling inside or outside of the indicated range of ranges identified in Table 1. As previously mentioned, research indicates that for weak project systems, and/or complex or otherwise risky projects, the high ranges may be two to three times the high range indicated in Table 1.

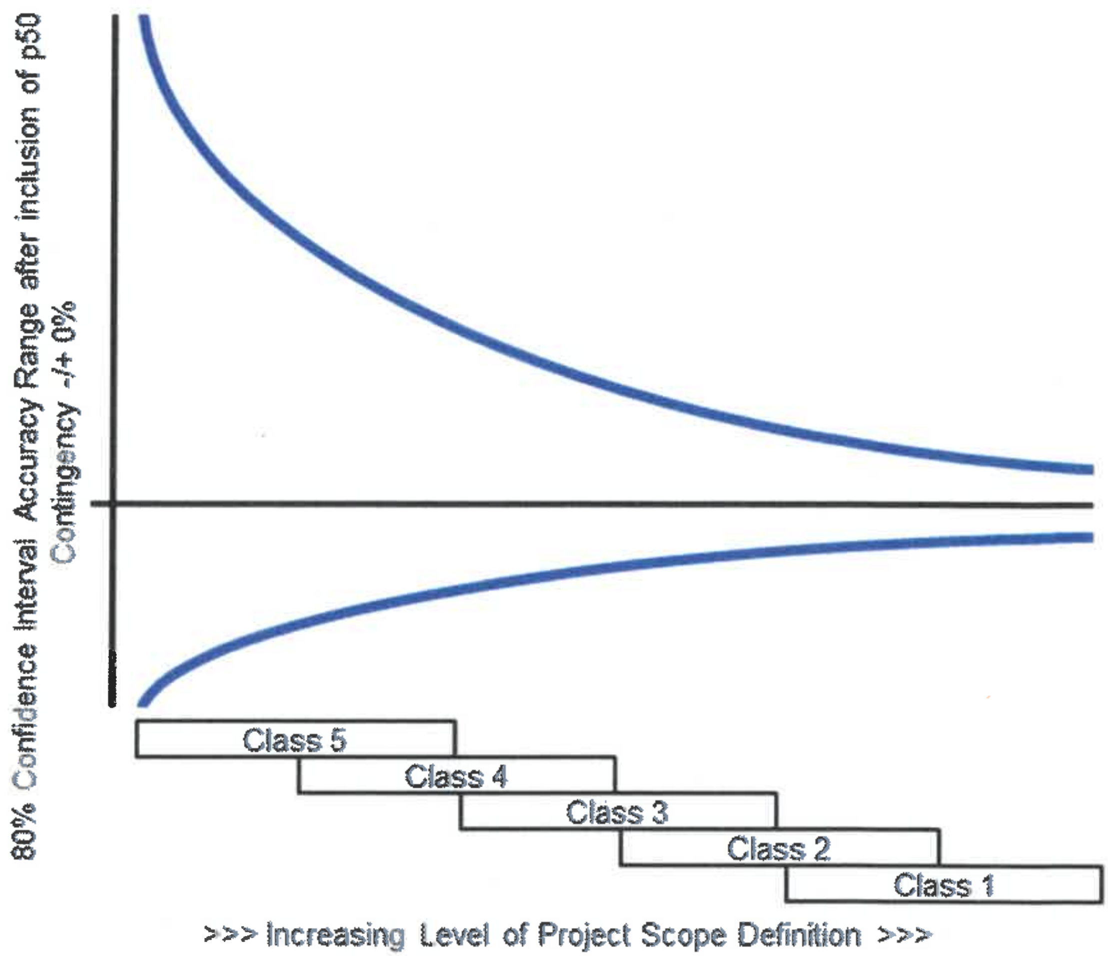

Figure 1 – Illustration of the Variability in Accuracy Ranges for Process Industry Estimates

4. DETERMINATION OF THE COST ESTIMATE CLASS

For a given project, the determination of the estimate class is based upon the maturity level of project definition based on the status of specific key planning and design deliverables. The percent design completion may be correlated with the status, but the percentage should not be used as the class determinate. While the determination of the status (and hence the estimate class) is somewhat subjective, having standards for the design input data, completeness and quality of the design deliverables will serve to make the determination more objective.

5. CHARACTERISTICS OF THE ESTIMATE CLASSES

The following tables (2a through 2e) provide detailed descriptions of the five estimate classifications as applied in the process industries. They are presented in the order of least-defined estimates to the most-defined estimates. These descriptions include brief discussions of each of the estimate characteristics that define an estimate class.

For each table, the following information is provided:

- **Description:** A short description of the class of estimate, including a brief listing of the expected estimate inputs based on the maturity level of project definition deliverables.
- **Maturity Level of Project Definition Deliverables (Primary Characteristic):** Describes a particularly key deliverable and a typical target status in stage-gate decision processes, plus an indication of approximate percent of full definition of project and technical deliverables. Typically, but not always, maturity level correlates with the percent of engineering and design complete.
- **End Usage (Secondary Characteristic):** A short discussion of the possible end usage of this class of estimate.
- **Estimating Methodology (Secondary Characteristic):** A listing of the possible estimating methods that may be employed to develop an estimate of this class.
- **Expected Accuracy Range (Secondary Characteristic):** Typical variation in low and high ranges after the application of contingency (determined at a 50% level of confidence). Typically, this represents about 80% confidence that the actual cost will fall within the bounds of the low and high ranges if contingency appropriately forecasts uncertainty and risks.
- **Alternate Estimate Names, Terms, Expressions, Synonyms:** This section provides other commonly used names that an estimate of this class might be known by. These alternate names are not endorsed by this recommended practice. The user is cautioned that an alternative name may not always be correlated with the class of estimate as identified in Tables 2a-2e.

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CLASS 5 ESTIMATE	
Description: Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systematic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with little effort expended—sometimes requiring less than an hour to prepare. Often, little more than proposed plant type, location, and capacity are known at the time of estimate preparation. **Maturity Level of Project Definition Deliverables:** Key deliverable and target status: Block flow diagram agreed by key stakeholders. List of key design basis assumptions. 0% to 2% of full project definition. **End Usage:** Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.	**Estimating Methodology:** Class 5 estimates generally use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, and other parametric and modeling techniques. **Expected Accuracy Range:** Typical accuracy ranges for Class 5 estimates are -20% to -50% on the low side, and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information and other risks (after inclusion of an appropriate contingency determination). Ranges could exceed those shown if there are unusual risks. **Alternate Estimate Names, Terms, Expressions, Synonyms:** Ratio, ballpark, blue sky, seat-of-pants, ROM, idea study, prospect estimate, concession license estimate, guesstimate, rule-of-thumb.

Table 2a – Class 5 Estimate

CLASS 4 ESTIMATE	
Description: Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Typically, engineering is from 1% to 15% complete, and would comprise at a minimum the following: plant capacity, block schematics, indicated layout, process flow diagrams (PFDs) for main process systems, and preliminary engineered process and utility equipment lists. **Maturity Level of Project Definition Deliverables:** Key deliverable and target status: Process flow diagrams (PFDs) issued for design. 1% to 15% of full project definition. **End Usage:** Class 4 estimates are prepared for a number of purposes, such as but not limited to, detailed strategic planning, business development, project screening at more developed stages, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval or approval to proceed to next stage.	**Estimating Methodology:** Class 4 estimates generally use factored estimating methods such as equipment factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, the Miller method, gross unit costs/ratios, and other parametric and modeling techniques. **Expected Accuracy Range:** Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side, and +20% to +50% on the high side, depending on the technological complexity of the project, appropriate reference information, and other risks (after inclusion of an appropriate contingency determination). Ranges could exceed those shown if there are unusual risks. **Alternate Estimate Names, Terms, Expressions, Synonyms:** Screening, top-down, feasibility (pre-feasibility for metals processes), authorization, factored, pre-design, pre-study.

Table 2b – Class 4 Estimate

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CLASS 3 ESTIMATE	
Description: Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. As such, they typically form the initial control estimate against which all actual costs and resources will be monitored. Typically, engineering is from 10% to 40% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, preliminary piping and instrument diagrams, plot plan, developed layout drawings, and essentially complete engineered process and utility equipment lists. Remedial action plan resulting from HAZOPs is identified. **Maturity Level of Project Definition Deliverables:** Key deliverable and target status: Piping and instrumentation diagrams (P&IDs) issued for design. 10% to 40% of full project definition. **End Usage:** Class 3 estimates are typically prepared to support full project funding requests, and become the first of the project phase control estimates against which all actual costs and resources will be monitored for variations to the budget. They are used as the project budget until replaced by more detailed estimates. In many owner organizations, a Class 3 estimate is often the last estimate required and could very well form the only basis for cost/schedule control.	**Estimating Methodology:** Class 3 estimates generally involve more deterministic estimating methods than conceptual methods. They usually involve predominant use of unit cost line items, although these may be at an assembly level of detail rather than individual components. Factoring methods may be used to estimate less-significant areas of the project. **Expected Accuracy Range:** Typical accuracy ranges for Class 3 estimates are -10% to -20% on the low side, and +10% to +30% on the high side, depending on the technological complexity of the project, appropriate reference information, and other risks (after inclusion of an appropriate contingency determination). Ranges could exceed those shown if there are unusual risks. **Alternate Estimate Names, Terms, Expressions, Synonyms:** Budget, scope, sanction, semi-detailed, authorization, preliminary control, concept study, feasibility (for metals processes) development, basic engineering phase estimate, target estimate.

Table 2c – Class 3 Estimate

CLASS 2 ESTIMATE	
Description: Class 2 estimates are generally prepared to form a detailed contractor control baseline (and update the owner control baseline) against which all project work is monitored in terms of cost and progress control. For contractors, this class of estimate is often used as the bid estimate to establish contract value. Typically, engineering is from 30% to 75% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, piping and instrument diagrams, heat and material balances, final plot plan, final layout drawings, complete engineered process and utility equipment lists, single line diagrams for electrical, electrical equipment and motor schedules, vendor quotations, detailed project execution plans, resourcing and work force plans, etc. **Maturity Level of Project Definition Deliverables:** Key deliverable and target status: All specifications and datasheets complete including for instrumentation. 30% to 75% of full project definition. **End Usage:** Class 2 estimates are typically prepared as the detailed contractor control baseline (and update to the owner control baseline) against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change management program. Some organizations may choose to make funding decisions based on a Class 2 estimate.	**Estimating Methodology:** Class 2 estimates generally involve a high degree of deterministic estimating methods. Class 2 estimates are prepared in great detail, and often involve tens of thousands of unit cost line items. For those areas of the project still undefined, an assumed level of detail takeoff (forced detail) may be developed to use as line items in the estimate instead of relying on factoring methods. **Expected Accuracy Range:** Typical accuracy ranges for Class 2 estimates are -5% to -15% on the low side, and +5% to +20% on the high side, depending on the technological complexity of the project, appropriate reference information, and other risks (after inclusion of an appropriate contingency determination). Ranges could exceed those shown if there are unusual risks. **Alternate Estimate Names, Terms, Expressions, Synonyms:** Detailed control, forced detail, execution phase, master control, engineering, bid, tender, change order estimate.

Table 2d – Class 2 Estimate

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CLASS 1 ESTIMATE	
Description: Class 1 estimates are generally prepared for discrete parts or sections of the total project rather than generating this level of detail for the entire project. The parts of the project estimated at this level of detail will typically be used by subcontractors for bids, or by owners for check estimates. The updated estimate is often referred to as the current control estimate and becomes the new baseline for cost/schedule control of the project. Class 1 estimates may be prepared for parts of the project to comprise a fair price estimate or bid check estimate to compare against a contractor's bid estimate, or to evaluate/dispute claims. Typically, overall engineering is from 65% to 100% complete (some parts or packages may be complete and others not), and would comprise virtually all engineering and design documentation of the project, and complete project execution and commissioning plans. **Maturity Level of Project Definition Deliverables:** Key deliverable and target status: All deliverables in the maturity matrix complete. 65% to 100% of full project definition. **End Usage:** Generally, owners and EPC contractors use Class 1 estimates to support their change management process. They may be used to evaluate bid checking, to support vendor/contractor negotiations, or for claim evaluations and dispute resolution. Construction contractors may prepare Class 1 estimates to support their bidding and to act as their final control baseline against which all actual costs and resources will now be monitored for variations to their bid. During construction, Class 1 estimates may be prepared to support change management.	**Estimating Methodology:** Class 1 estimates generally involve the highest degree of deterministic estimating methods, and require a great amount of effort. Class 1 estimates are prepared in great detail, and thus are usually performed on only the most important or critical areas of the project. All items in the estimate are usually unit cost line items based on actual design quantities. **Expected Accuracy Range:** Typical accuracy ranges for Class 1 estimates are -3% to -10% on the low side, and +3% to +15% on the high side, depending on the technological complexity of the project, appropriate reference information, and other risks (after inclusion of an appropriate contingency determination). Ranges could exceed those shown if there are unusual risks. **Alternate Estimate Names, Terms, Expressions, Synonyms:** Full detail, release, fall-out, tender, firm price, bottoms-up, final, detailed control, forced detail, execution phase, master control, fair price, definitive, change order estimate.

Table 2e – Class 1 Estimate

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6. ESTIMATE INPUT CHECKLIST AND MATURITY MATRIX

Table 3 maps the extent and maturity of estimate input information (deliverables) against the five estimate classification levels. This is a checklist of basic deliverables found in common practice in the process industries. The maturity level is an approximation of the completion status of the deliverable. The completion is indicated by the following descriptors:

General Project Data:

- **Not Required (NR):** May not be required for all estimates of the specified class, but specific project estimates may require at least preliminary development.
- **Preliminary (P):** Project definition has begun and progressed to at least an intermediate level of completion. Review and approvals for its current status has occurred.
- **Defined (D):** Project definition is advanced, and reviews have been conducted. Development may be near completion with the exception of final approvals.

Technical Deliverables:

- **Not Required (NR):** Deliverable may not be required for all estimates of the specified class, but specific project estimates may require at least preliminary development.
- **Started (S):** Work on the deliverable has begun. Development is typically limited to sketches, rough outlines, or similar levels of early completion.
- **Preliminary (P):** Work on the deliverable is advanced. Interim, cross-functional reviews have usually been conducted. Development may be near completion except for final reviews and approvals.
- **Complete (C):** The deliverable has been reviewed and approved as appropriate.

MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES	ESTIMATE CLASSIFICATION				
	CLASS 5	CLASS 4	CLASS 3	CLASS 2	CLASS 1
	0% to 2%	1% to 15%	10% to 40%	30% to 75%	65% to 100%
GENERAL PROJECT DATA:					
A. SCOPE:					
Non-Process Facilities (Infrastructure, Ports, Pipeline, Power Transmission, etc.)	P	P	D	D	D
Project Scope of Work Description	P	P	D	D	D
Byproduct and Waste Disposal	NR	P	D	D	D
Site Infrastructure (Access, Construction Power, Camp etc.)	NR	P	D	D	D
B. CAPACITY:					
Plant Production / Facility (includes power facilities)	P	P	D	D	D
Electrical Power Requirements (when not the primary capacity driver)	NR	P	D	D	D

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MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES	ESTIMATE CLASSIFICATION				
	CLASS 5	CLASS 4	CLASS 3	CLASS 2	CLASS 1
	0% to 2%	1% to 15%	10% to 40%	30% to 75%	65% to 100%
C. PROJECT LOCATION:					
Plant and Associated Facilities	P	P	D	D	D
D. REQUIREMENTS:					
Codes and/or Standards	NR	P	D	D	D
Communication Systems	NR	P	D	D	D
Fire Protection and Life Safety	NR	P	D	D	D
Environmental Monitoring	NR	NR	P	P	D
E. TECHNOLOGY SELECTION:					
Process Technology	P	P	D	D	D
F. STRATEGY:					
Contracting / Sourcing	NR	P	D	D	D
Escalation	NR	P	D	D	D
G. PLANNING:					
Logistics Plan	P	P	P	D	D
Integrated Project Plan[1]	NR	P	D	D	D
Project Code of Accounts	NR	P	D	D	D
Project Master Schedule	NR	P	D	D	D
Regulatory Approval & Permitting	NR	P	D	D	D
Risk Register	NR	P	D	D	D
Stakeholder Consultation / Engagement / Management Plan	NR	P	D	D	D
Work Breakdown Structure	NR	P	D	D	D
Startup and Commissioning Plan	NR	P	P/D	D	D
H. STUDIES:					
Environmental Impact / Sustainability Assessment	NR	P	D	D	D
Environmental / Existing Conditions	NR	P	D	D	D
Soils and Hydrology	NR	P	D	D	D
TECHNICAL DELIVERABLES:					
Block Flow Diagrams	S/P	C	C	C	C
Equipment Datasheets	NR/S	P	C	C	C
Equipment Lists: Electrical	NR/S	P	C	C	C

[1] The integrated project plan (IPP), project execution plan (PEP), project management plan (PMP), or more broadly the project plan, is a high-level management guide to the means, methods and tools that will be used by the team to manage the project. The term integration emphasizes a project life cycle view (the term execution implying post-sanction) and the need for alignment. The IPP covers all functions (or phases) including engineering, procurement, contracting strategy, fabrication, construction, commissioning and startup within the scope of work. However, it also includes stakeholder management, safety, quality, project controls, risk, information, communication and other supporting functions. In respect to estimate classification, to be rated as *defined*, the IPP must cover all the relevant phases/functions in an integrated manner aligned with the project charter (i.e., objectives and strategies); anything less is *preliminary*. The overall IPP cannot be rated as *defined* unless all individual elements are defined and integrated.

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MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES	ESTIMATE CLASSIFICATION				
	CLASS 5	CLASS 4	CLASS 3	CLASS 2	CLASS 1
	0% to 2%	1% to 15%	10% to 40%	30% to 75%	65% to 100%
Equipment Lists: Process / Utility / Mechanical	NR/S	P	C	C	C
Heat & Material Balances	NR	C	C	C	C
Process Flow Diagrams (PFDs)	NR	C	C	C	C
Utility Flow Diagrams (UFDs)	NR	C	C	C	C
Design Specifications	NR	S/P	C	C	C
Electrical One-Line Drawings	NR	S/P	C	C	C
General Equipment Arrangement Drawings	NR	S/P	C	C	C
Instrument List	NR	S/P	C	C	C
Piping & Instrument Diagrams (P&IDs)	NR	S/P	C	C	C
Plot Plans / Facility Layouts	NR	S/P	C	C	C
Construction Permits	NR	S/P	P/C	C	C
Civil / Site / Structural / Architectural Discipline Drawings	NR	S/P	P	C	C
Demolition Plan and Drawings	NR	S/P	P	C	C
Erosion Control Plan and Drawings	NR	S/P	P	C	C
Fire Protection and Life Safety Drawings and Details	NR	S/P	P	C	C
Electrical Schedules	NR	NR/S	P	P/C	C
Instrument and Control Schedules	NR	NR/S	P	P/C	C
Instrument Datasheets	NR	NR/S	P	P/C	C
Piping Schedules	NR	NR/S	P	P/C	C
Piping Discipline Drawings	NR	NR/S	S/P	C	C
Spare Parts Listings	NR	NR	P	P/C	C
Electrical Discipline Drawings	NR	NR	S/P	P/C	C
Facility Emergency Communication Plan and Drawings	NR	NR	S/P	P/C	C
Information Systems / Telecommunication Drawings	NR	NR	S/P	P/C	C
Instrumentation / Control System Discipline Drawings	NR	NR	S/P	P/C	C
Mechanical Discipline Drawings	NR	NR	S/P	P/C	C

Table 3 – Estimate Input Checklist and Maturity Matrix (Primary Classification Determinate)

7. BASIS OF ESTIMATE DOCUMENTATION

The basis of estimate (BOE) typically accompanies the cost estimate. The basis of estimate is a document that describes how an estimate is prepared and defines the information used in support of development. A basis document commonly includes, but is not limited to, a description of the scope included, methodologies used, references and defining deliverables used, assumptions and exclusions made, clarifications, adjustments, and some indication of the level of uncertainty.

The BOE is, in some ways, just as important as the estimate since it documents the scope and assumptions; and provides a level of confidence to the estimate. The estimate is incomplete without a well-documented basis of estimate. See AACE Recommended Practice 34R-05 *Basis of Estimate* for more information [12].

8. PROJECT DEFINITION RATING SYSTEM

An additional step in documenting the maturity level of project definition is to develop a project definition rating system. This is another tool for measuring the completeness of project scope definition. Such a system typically provides a checklist of scope definition elements and a scoring rubric to measure maturity or completeness for each element. A better project definition rating score is typically associated with a better probability of achieving project success.

Such a tool should be used in conjunction with the AACE estimate classification system; it does not replace estimate classification. A key difference is that a project definition rating measures overall maturity across a broad set of project definition elements, but it usually does not ensure completeness of the key project definition deliverables required to meet a specific class of estimate. For example, a good project definition rating may sometimes be achieved by progressing on additional project definition deliverables, but without achieving signoff or completion of a key deliverable.

AACE estimate classification is based on ensuring that key project deliverables have been completed or met the required level of maturity. If a key deliverable that is indicated as needing to be complete for Class 3 (as an example) has not actually been completed, then the estimate cannot be regarded as Class 3 regardless of the maturity or progress on other project definition elements.

An example of a project definition rating system is the *Project Definition Rating Index* developed by the Construction Industry Institute. It has developed several indices for specific industries, such as IR113-2 [13] for the process industry and IR115-2 [14] for the building industry. Similar systems have been developed by the US Department of Energy [15].

9. CLASSIFICATION FOR LONG-TERM PLANNING AND ASSET LIFE CYCLE COST ESTIMATES

As stated in the Purpose section, classification maps the phases and stages of project cost estimating. Typically, in a phase-gate project system, scope definition and capital cost estimating activities flow from framing a business opportunity through to a capital investment decision and eventual project completion in a more-or-less steady, short-term (e.g., several years) project life-cycle process.

Cost estimates are also prepared to support long-range (e.g., perhaps several decades) capital budgeting and/or asset life cycle planning. Asset life cycle estimates are also prepared to support net present value (e.g., estimates for initial capital project, sustaining capital, and decommissioning projects), value engineering and other cost or economic studies. These estimates are necessary to address sustainability as well. Typically, these long-range estimates are based on minimal scope definition as defined for *Class 5*. However, these asset life cycle "conceptual" estimates are prepared so far in advance that it is virtually assured that the scope will change from even the minimal level of definition assumed at the time of the estimate. Therefore, the expected estimate accuracy values reported in Table 1 (percent that actual cost will be over or under the estimate including contingency) are not meaningful because the Table 1 accuracy values explicitly *exclude scope change*. For long-term estimates, one of the following two classification approaches is recommended:

- If the long-range estimate is to be updated or maintained periodically in a controlled, documented life cycle process that addresses scope and technology changes in estimates over time (e.g., nuclear or other licensing may require that future decommissioning estimates be periodically updated), the estimate is rated as *Class 5* and the Table 1 accuracy ranges are assumed to apply for the specific scope included in the estimate at the time of estimate preparation. Scope changes are explicitly excluded from the accuracy range.

- If the long-range estimate is performed as part of a process or analysis where scope and technology change is not expected to be addressed in routine estimate updates over time, the estimate is rated as *Unclassified* or as *Class 10* (if a class designation is required to meet organizational procedures), and the Table 1 accuracy ranges cannot be assumed to apply. The term *Class 10* is specifically used to distinguish these long-range estimates from the relatively short time-frame *Class 5* through *Class 1* capital cost estimates identified in Table 1 and this RP; and to indicate the order-of-magnitude difference in potential expected estimate accuracy due to the infrequent updates for scope and technology. Unclassified (or Class 10) estimates are not associated with indicated expected accuracy ranges.

In all cases, a *Basis of Estimate* should be documented so that the estimate is clearly understood by those reviewing and/or relying on them later. Also, the estimating methods and other characteristics of Class 5 estimates generally apply. In other words, an *Unclassified* or *Class 10* designation must not be used as an excuse for unprofessional estimating practice.

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APPENDIX: UNDERSTANDING ESTIMATE CLASS AND COST ESTIMATE ACCURACY

Despite the verbiage included in the RP, often, there are still misunderstandings that the class of estimate, as defined in the RP above, defines an expected accuracy range for each estimate class. This is incorrect. The RP clearly states that "while a target range may be expected for a particular estimate, the accuracy range should always be determined through risk analysis of the specific project and should never be predetermined." Table 1 and Figure 1 in the RP are intended to illustrate only the general relationship between estimate accuracy and the level of project definition. For the process industries, typical estimate ranges described in RP 18R-97 above are shown as a range of ranges:

- Class 5 Estimate:
  - High range typically ranges from +30% to +100%
  - Low range typically ranges from -20% to -50%
- Class 4 Estimate:
  - High range typically ranges from +20% to +50%
  - Low range typically ranges from -15% to -30%
- Class 3 Estimate:
  - High range typically ranges from +10% to +30%
  - Low range typically ranges from -10% to -20%
- Class 2 Estimate:
  - High range typically ranges from +5% to +20%
  - Low range typically ranges from -5% to -15%
- Class 1 Estimate:
  - High range typically ranges from +3% to +15%
  - Low range typically ranges from -3% to -10%

As indicated in the RP, these +/- percentage members associated with an estimate class are intended as rough indicators of the accuracy relationship. They are merely a useful simplification given the reality that every individual estimate will be associated with a unique probability distribution correlated with its specific level of uncertainty. As indicated in the RP, estimate accuracy should be determined through a risk analysis for each estimate.

It should also be noted that there is no indication in the RP of contingency determination being based on the class of estimate. AACE has recommended practices that address contingency determination and risk analysis methods (for example RP 40R-08, *Contingency Estimating – General Principles* [9]). Furthermore, the level of contingency required for an estimate is not the same as the upper limits of estimate accuracy (as determined by a risk analysis).

The results of the estimating process are often conveyed as a single value of cost or time. However, since estimates are predications of an uncertain future, it is recommended that all estimate results should be presented as a probabilistic distribution of possible outcomes in consideration of risk.

Every estimate is a prediction of the expected final cost or duration of a proposed project or effort (for a given scope of work). By its nature, an estimate involves assumptions and uncertainties. Performing the work is also subject to risk conditions and events that are often difficult to identify and quantify. Therefore, every estimate presented as a single value of cost or duration will likely deviate from the final outcome (i.e., statistical error). In simple terms, this means that every point estimate value will likely prove to be wrong. Optimally, the estimator will analyze the uncertainty and risks and produce a probabilistic estimate that provides decision makers with the probabilities of over-running or under-running any particular cost or duration value. Given this probabilistic nature of an estimate, an estimate should not be regarded as a single point cost or duration. Instead, an estimate actually reflects a range of potential outcomes, with each value within this range associated with a probability of occurrence.

Individual estimates should always have their accuracy ranges determined by a quantitative risk analysis study that results in an estimate probability distribution. The estimate probability distribution is typically skewed. Research shows the skew is typically to the right (positive skewness with a longer tail to the right side of the distribution) for large and complex projects. In part, this is because the impact of risk is often unbounded on the high side.

High side skewness implies that there is potential for the high range of the estimate to exceed the median value of the probability distribution by a higher absolute value than the difference between the low range of the estimate and the median value of the distribution.

Figure A1 shows a positively skewed distribution for a sample cost estimate risk analysis that has a point base estimate (the value before adding contingency) of $89.5. In this example, a contingency of $4.5 (approximately 5%) is required to achieve a 50% probability of underrun, which increases the final estimate value after consideration of risk to $93. Note that this example is intended to describe the concepts but not to recommend specific confidence levels for funding contingency or management reserves of particular projects; that depends on the stakeholder risk attitude and tolerance.

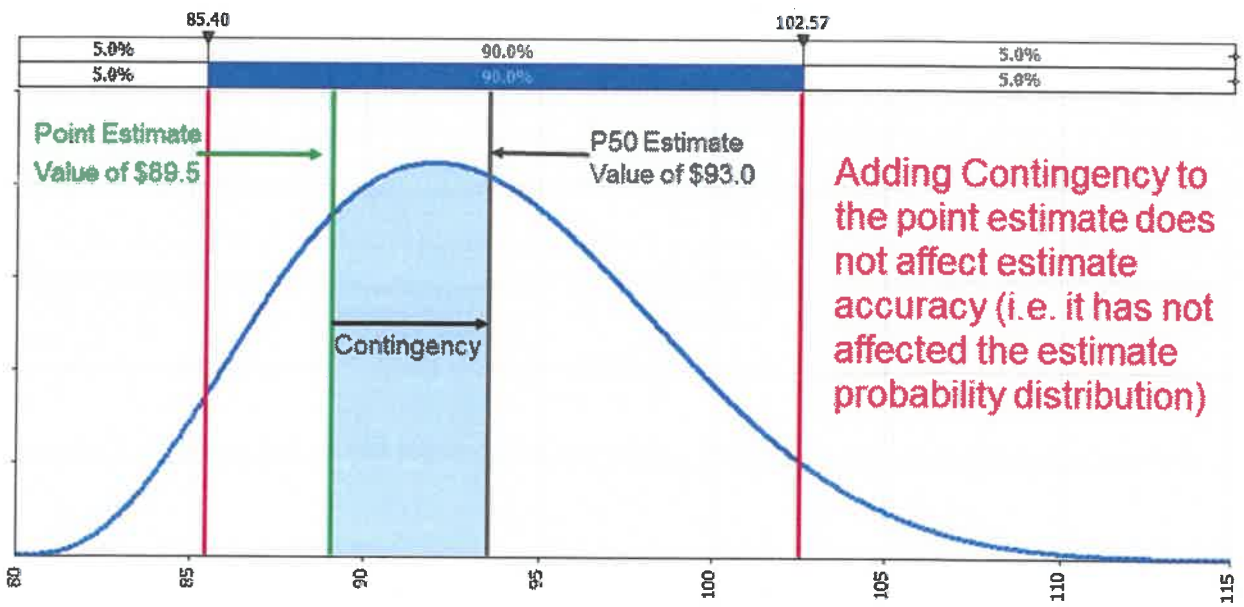

Figure – A1: Example of an Estimate Probability Distribution at a 90% Confidence Interval

Note that adding contingency to the base point estimate does not affect estimate accuracy in absolute terms as it has not affected the estimate probability distribution (i.e., high and low values are the same). Adding contingency simply increases the probability of underrunning the final estimate value and decreases the probability of overrunning the final estimate value. In this example, the estimate range with a 90% confidence interval remains between approximately $85 and $103 regardless of the contingency value.

As indicated in the RP, expected estimate accuracy tends to improve (i.e., the range of probable values narrows) as the level of project scope definition improves. In terms of the AACE International estimate classifications, increasing levels of project definition are associated with moving from Class 5 estimates (lowest level of scope definition) to Class 1 estimates (highest level of scope definition), as shown in Figure 1 of the RP. Keeping in mind that accuracy is an expression of an estimate's predicted closeness to the final actual value; anything included in that final actual cost, be it the result of general uncertainty, risk conditions and events, price escalation, currency or anything else within the project scope, is something that estimate accuracy measures must communicate in some manner. With that in mind, it should be clear why standard accuracy range values are not applicable to individual estimates.

The level of project definition reflected in the estimate is a key risk driver and hence is at the heart of estimate classification, but it is not the only driver of estimate risk and uncertainty. Given all the potential sources of risk and uncertainty that will vary for each specific estimate, it is simply not possible to define a range of estimate accuracy solely based on the level of project definition or class of estimate.