APPENDIX H

Application of the Tier 1 and Tier 2 Approaches to a Hypothetical Project

This appendix demonstrates the application of Tier 1 and Tier 2 to a hypothetical project. The reader is encouraged to review this worked example to better understand the proposed methodology and to clarify any ambiguities.

Tier 1—Analytical Delivery Decision Approach (Hypothetical Project)

In order to test the Tier 1—Analytical Delivery Decision Approach, a hypothetical project was developed. This hypothetical project was then used to move through the Tier 1 process step by step, with the assistance of a public transportation authority official. This approach provided the benefits of (1) testing the Tier 1—Analytical Delivery Decision Approach with the participation of a public transportation agency official, (2) generating feedback from a public transportation agency official on the usefulness and effectiveness of the approach, and (3) providing an example that can be followed by other users of this methodology. The results of the test are given below. For ease of reference, tables and templates from Appendices D and E that are also used in this appendix have their Appendix D or E number provided in parentheses following their Appendix H number, for example: Table H-1 (D-1).

Step 1. Create Project Description

Project Name: Big Apple Underground Busway

Location: Big Apple, USA

Mode of Transportation: Bus Rapid Transit

Estimated Budget: $1Billion

Estimated Project Delivery Period: 8 years

Required Delivery Date: N/A

Sources of Project Funding: FTA funding, passenger revenues

Project Type: Bus Rapid Transit tunnel under city streets

Project Corridor: Boat section entry portal on Chambers St. at Wall St., west on Chambers St. for about 3000LF, south on West St. about 1200LF, boat section portal at Vesey St.

Project Corridor Dimensions: Twin tunnels approximately 25' diameter each, top of invert average approximately 40' below grade, bottom of invert average approximately 70' below grade, depths vary along alignment

Major Features of Work: Twin tunnels, two underground stations with platforms, boat section portal to city streets at each end, turnaround/loop beneath intersection of Chambers St. and West St., support facilities (including yards, shops, and administrative bldgs.).

Ridership Forecast: not available

Rate of Return/Payback Period on Capital Investment: not available

Major Schedule Milestones:
15% Design Completion
30% Design Completion
60% Design Completion
90% Design Completion
100% Design Completion
Procure Buses
Procure Construction Contracts
Tunnel Construction Completion
Station 1 Construction Completion
Station 2 Construction Completion
Bus Delivery
Testing & Start-up
Revenue Operations

Major Project Stakeholders: FTA, Big Apple Transit Authority (BATA), City of Big Apple, Neighborhood/Abutters

Labor Union Status: Union Construction Workforce, Union BATA Operations & Maintenance Work Force

Major Challenges:

- Congested urban environment
- Penetrating/relocating existing subsurface utilities
- Removal and disposal of excavated materials
- Top-down access for cut & cover station construction
- Construction contract packaging
- Construction contract interfaces
- Third-party abutters
- Big Apple Transportation Department (BATD)– traffic control, detours, access to city streets
- Construction of boat section portals on city streets
- Limited construction lay-down area available
- Stabilization and underpinning of old, existing tunnels

Main Identified Sources of Risk:

- Uncertainty of subsurface geotechnical conditions
- Third-party abutter impacts
- Extremely narrow construction corridor
- Instability of old, existing tunnels
- Plan for removal and disposal of excavated materials
- BATA Cooperation—traffic restraints, detour approvals
- Tunneling under active, congested urban environment

- Limited construction lay-down area
- Neighborhood opposition

Sustainable Design and Construction Requirements: green design, buses with electric underground mode, simple sustainable finishes in stations and tunnels, durable and flexible communications and signals

Step 2. Define Project Goals

1. Deliver project at or below budget (budget will be established at 30% design)
2. Optimize project schedule (escalation and project overheads are significant cost factors)
3. This must be an affordable, appealing mode of transportation for riders (revenue stream)
4. Minimize disruption to the public/abutters
5. All facilities (tunnels, systems, stations, buildings) must be simple and sustainable with minimized O&M requirements and costs

Step 3. Review Go/No Go Decision Points

Table H-1 - Go/No-Go Issue Summary

	DBB	CMR	DB	DBOM
Project Schedule Constraints	✓			
Federal/State/Local Laws		✓	✓	✓
Third-Party Agreements			✓	✓
Labor Unions				**X**

Key: ✓ = Go; **X** = No Go

Comments: For the purposes of testing this hypothetical project, it was assumed that there are no project schedule constraints prohibiting the use of DBB; there are no local, state, or federal laws prohibiting the use of DBB, CMR, DB, or DBOM contracts; and there are no third-party agreements prohibiting the use of DB or DBOM contracts. The assumption was also made that BATA has an internal union work force in place for the operation and maintenance of bus rapid transit systems and facilities. Accordingly, the use of DBOM as a project delivery method was eliminated as indicated in the Go/No-Go Summary above.

Step 4. Review Project Delivery Method Advantages and Disadvantages

The use of DBOM was eliminated in Step 3, leaving only DBB, CMR, and DB as potential project delivery methods. A critical examination of the advantages and disadvantages of these three project delivery methods was then performed by analyzing each of the 24 issues listed in Tier 1 (see Chapter 4). For the purposes of this test, the analysis of each of the 24 issues was recorded by using the tables from Appendix D. The check boxes for each issue were reviewed, the *most relevant* check boxes were checked, and the others were left blank. The summary tables at the end of each issue were then completed using the rating key from

Chapter 4 and Appendix D. Any comments were recorded at the end of each of the 24 issues. The results of this analysis for each issue are as follows.

Project Level Issues

1) Project Size

Project size reflects the dollar value and physical dimensions of the transit corridor.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓DBB has been shown to work on projects of all sizes.	❒ As projects grow in size, the amount of owner staffing required to oversee DBB can become very large.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓CMR has been shown to work on projects of all sizes.	❒ If not managed well, the use of multiple bid packages to facilitate CMR can be difficult.

DESIGN-BUILD	
Advantages	Disadvantages
✓DB has been shown to work on projects of all sizes. ✓Some owners have noted that DB can facilitate better management of large projects due to the single source of responsibility.	❒ As projects grow in size, there can be large peaks in owner staffing requirements with DB (e.g., during RFP development, during design review, etc.).

Table H-2 (D-1): Project Size Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
1. Project Size	◘	◘	◘	X

Key: ● Most appropriate delivery method
◘ Appropriate delivery method
○ Least appropriate delivery method
X Not Applicable (discontinue evaluation of this method)

Comments: BATA internal staff capabilities and size were deemed sufficient to manage this project, regardless of its size—thus no disadvantages were checked.

2) Cost

This issue represents several aspects of project cost, such as ability to handle budget restrictions, early and precise cost estimation, and consistent control of project costs.

DESIGN-BID-BUILD	
Advantages	Disadvantages
❒ Costs are known at bid time, before construction begins. ❒ Project can benefit from low-bid procurement. ❒ Project can benefit from unit price bidding because quantities are defined prior to procurement.	❒ Construction costs are not fixed (or locked in) until design is 100% complete. ✓ Constructability advice and contractor innovations are not available to save cost until post bid. ✓ The DBB process is prone to change orders and cost growth after award.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
❒ CMR can be used in conjunction with a GMP pricing structure, which can be useful in negotiating and controlling costs. ❒ If open book pricing can be used, all costs will be known by the owner. ✓ Costs will be known earlier when compared to DBB. ✓ Early constructor involvement or construction advice can lead to cost savings through value engineering and constructability reviews.	✓ If multiple bid packages are used, the overall project cost could grow if later bid packages cost more than estimated. ✓ If a GMP pricing structure is used, owners may have some difficulty in negotiation.

DESIGN-BUILD	
Advantages	Disadvantages
✓ If a lump sum pricing structure is used, costs will be fixed early in the project development process. ✓ DB has been shown to have lower average cost growth than DBB or CMR.	✓ If a lump sum pricing structure is used, constructors must develop prices before plans are 100% complete and therefore must assume some risk in pricing.

Table H-3 (D-2): Cost Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
2. Cost	○	◘	●	X

Comments: It is assumed that a well-written DB contract will minimize the potential for cost growth. CMR is considered more advantageous than DBB because of the ability to obtain contractor constructability and cost savings input during design. CMR is less advantageous than DB because BATA feels that it will be difficult to negotiate a Guaranteed Maximum Price with a CMR for this tunnel project in light of unknown subsurface conditions.

3) Schedule

This factor shows two aspects of project schedule and includes both the ability to shorten the schedule and the opportunity to control and prevent time growth.

DESIGN-BID-BUILD	
Advantages	Disadvantages
❒ None.	✓ Likely to yield longest delivery schedule. ❒ Likely to yield the highest schedule growth. ✓ There is a lack of opportunity to compress schedule due to the linear nature of DBB.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Facilitates fast-tracking or the ability to bid multiple design packages. ✓ Studies have shown that CMR is faster on average than DBB, but slower than DB.	❒ Risk that overlapping design and construction packages may create delays if not properly coordinated. ✓ Fast-tracking schedule will require owner effort in design and construction reviews.

DESIGN-BUILD	
Advantages	Disadvantages
✓ Provides a single point of responsibility (DB contractor) for schedule control. ✓ Provides early scheduled certainty. ❒ Historically, provides the least schedule growth. ✓ Provides opportunities for flexibility in schedule compression. ❒ Studies have shown that DB is faster on average than DBB or CMR.	✓ Owner will sacrifice the checks and balances of having complete design prior to start of construction. ✓ Rapid schedule will require owner effort in design and construction reviews.

Table H-4 (D-3): Schedule Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
3. Schedule	○	◘	◘	X

Comments: BATA felt that CMR and DB are equally advantageous to schedule optimization.

4) Risk Management

The issue details methods to cope with project uncertainties that are inherent to each delivery method. For more detailed guidance, please see Tier 3 for a risk-based approach to selecting project delivery systems.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ Provides historically well-defined and well-understood risk-management processes. ✓ Prescriptive designs and specifications allow for greater detail in risk allocation.	✓ Constructor cannot participate in risk management during design. ✓ Constructor's ability to manage risk is constrained by low-bid procurement.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Construction manager understands and participates in risk-management process during design.	❒ Risk-management process can be more complex due to separate design, construction, and construction management contracts.

DESIGN-BUILD	
Advantages	Disadvantages
✓ Single point of responsibility for risk management in design and construction.	✓ Owner may lose some ability to participate in the risk-management process.

Table H-5 (D-4): Risk Management Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
4. Risk Management	o	●	o	X

Comments: CMR provides the best opportunity to manage risk because of contractor participation during design and the opportunity to negotiate risk allocation.

5) Risk Allocation

Each project delivery method has inherent risk-allocation characteristics. The overarching goal should be to select the project delivery method with the best ability to assign project risks to the parties in the best position to manage them.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ A clear risk allocation has been established due to history of use and statutory case law.	✓ Constructor cannot participate in risk-allocation discussions during design. ✓ Conflicts can exist in risk allocation between separate design and construction contracts.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Construction manager understands and participates in risk allocation during design. ❒ Prescriptive designs and specifications allow for greater detail in risk allocation.	✓ Conflicts can exist in risk allocation among separate design, construction, and construction management contracts.

DESIGN-BUILD	
Advantages	Disadvantages
✓ Provides a single party for risk allocation in both design and construction. ✓ Design-builder owns risk for design errors and omissions.	✓ Risks must be allocated through conceptual design and performance specifications.

Table H-6 (D-5): Risk-Allocation Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
5. Risk Allocation	o	o	o	x

Comments: BATA felt that risk could be managed by effective contract language and management, regardless of project delivery method.

6) LEED Certification

Each project delivery method has some inherent abilities to include these features in accordance with the owner's needs.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ LEED certification can be established in more detail during design period.	❒ Provides the least opportunity for constructor to participate in LEED process during design.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Construction manager can offer its construction expertise during design decisions that involve LEED issues.	❒ Separate design packages can create difficulty in coordinating LEED elements in construction.

DESIGN-BUILD	
Advantages	Disadvantages
✓ Owner can use some LEED certification elements to select constructor. ✓ Single point of responsibility is provided for LEED certification in design and construction.	❒ Owner may not be involved in all LEED decisions.

Table H-7 (D-6): LEED Certification Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
6. LEED Certification	o	o	o	x

Comments: BATA felt that none of the project delivery methods provided a distinct advantage over the others for obtaining LEED certification on this project.

Agency Level Issues

7) Agency Experience

The level of experience of an owner's staff can affect the success of an alternative delivery method application.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ Since this is the traditional method of project delivery, owners will likely have the most experience with this method.	❒ None.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ CMR is similar to DBB in many key aspects where agencies have experience (e.g., separation of design and construction).	✓ Agencies may not have experience with GMP pricing or the negotiation that can be involved. ❒ Agencies may not have experience in the use of multiple bid packages to facilitate fast-track construction.

DESIGN-BUILD	
Advantages	Disadvantages
✓ Agencies can take advantage of the sole point of responsibility for design and construction to leverage their experience.	❒ Agencies may not have experience authoring DB RFPs and conducting procurements. ❒ Agencies may not have experience administering DB contracts, particularly in the area of design review and administration. ❒ DB necessitates experienced staff to manage design and construction under one contract.

Table H-8 (D-7): Agency Experience Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
7. Agency Experience	⊙	○	⊙	X

Comments: BATA staff has no experience negotiating a Guaranteed Maximum Price with a CMR, thereby rendering CMR the least appropriate delivery method.

8) Staffing Required

The total number of required owner's employees for each delivery method is one measure of the extent of owner involvement. A second measure is the variation in the number of staff required throughout the project development process.

DESIGN-BID-BUILD	
Advantages	Disadvantages
❒ The separation of design and construction phases provides less variation in owner staffing levels.	❒ DBB typically requires a larger owner staff than the other delivery methods. ✓ DBB typically requires a higher level of owner involvement.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
❒ The CMR alternative can use the least number of owner staff if the CMR is allowed to take on the traditional owner tasks.	✓ The owner will need to have a number of staff with the ability to oversee and negotiate with the CMR during the process.

DESIGN-BUILD	
Advantages	Disadvantages
✓ DB can greatly reduce the number of required owner staff. ❒ Design and construction reviews can be done in shorter periods of time.	❒ DB creates peaks in owner staffing needs, particularly during procurement and design review periods. ❒ While fewer owner staff is needed, more experienced staff is required.

Table H-9 (D-8): Staff Required Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
8. Staff Required	⭘	⭘	●	X

Comments: Based on previous DBB and DB project experience, BATA feels that DB requires the least amount of BATA staff.

9) Staff Capability

This issue involves the owner's requirement to furnish a highly capable staff to complete the duties it must undertake in each delivery method.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ DBB is traditionally aligned with owner staff capabilities.	❒ As projects grow in size, more experienced staff is required. ✓ Owners typically have different staff to oversee design and construction processes.

❒

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
❒ The CMR can augment an owner's capabilities with his own staff.	✓ Owners must have experienced staff to oversee the CMR. ✓ Owners may lack some capabilities in negotiating prices developing designs.

DESIGN-BUILD	
Advantages	Disadvantages
✓ The owners will be able to rely on one source of responsibility for both design and construction.	✓ Similar to CMR, DB is an alternative delivery method, and it is advisable to have a staff with DB oversight experience. ❒ Owners will need capabilities to develop procurement documents and performance criteria. ❒ Owners will need to have capabilities of reviewing design under a DB contract.

Table H-10 (D-9): Staff Capability Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
9. Staff Capability	●	○	⊙	X

Comments: BATA has historically executed nearly all projects as DBB. BATA has some DB experience and is relatively comfortable with the capability of its staff to execute DB contracts. BATA has never executed CMR and is uncertain of its capability to effectively negotiate a GMP with a CMR contractor, especially on a tunnel project in light of unknown subsurface conditions.

10) Agency Goals and Objectives

Agency goals define project success. The extent to which these goals align with the inherent attributes of each project delivery method have a significant bearing on delivery method selection.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ The DBB process allows for goals to be defined through the design process.	✓ Separate design and construction contracts can make goals more difficult to align and manage. ❒ If not developed correctly, detailed designs and prescriptive specifications can conflict with agency goals.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Agency can involve the CMR in refinement of goals while working together to refine the scope and the GMP. ❒ Qualifications-based construction manager selection can align the team with the project goals.	❒ The agency must have the goals substantially developed when the construction manager contract is awarded. ✓ The negotiation of a GMP may inhibit the alignment of project goals between the agency and the construction manager.

DESIGN-BUILD	
Advantages	Disadvantages
✓ Best-value design-builder selection can align the team with the project goals. ❒ Properly written procurement performance criteria can help design-builders innovate to achieve project goals.	❒ To ensure success, agencies must completely understand goals prior to awarding the DB contract.

Table H-11 (D-10): Agency Goals and Objectives Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
10. Agency Goals and Objectives	o	o	o	x

Comments: BATA feels that it is up to its own staff and consultants to achieve project goals, regardless of project delivery method.

11) Agency Control of Project

The owner's ability to control the details of design and construction varies with each project delivery method. (Note that cost control and time control are described in other issues).

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ The use of prescriptive specifications and complete designs at the time of award provides agencies with the most control over the project. ❒ Separate design and construction contracts provide clear checks and balances.	❒ With additional control come added activities and responsibility for agency staff. ✓ The DBB method can be prone to change orders if any design conflicts or constructability issues are found.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ The CMR method benefits from early constructor involvement, but still has the benefit of separate design and construction contracts.	✓ Agency control of CMR delivery requires more effort due to the use of multiple design packages and the need for a GMP pricing structure.

DESIGN-BUILD	
Advantages	Disadvantages
❒ The transfer of design liability lessens the need for agency control over design.	✓ Award at a conceptual design level means that the agency will lose control over the details of the final design.

Table H-12 (D-11): Agency Control of Project Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
11. Agency Control of Project	⊙	⊙	○	X

Comments: BATA feels the loss of close control of design detail after 30% makes DB the least appropriate delivery method.

12) Third-Party Agreement

Each delivery method can facilitate agreements with third parties, such as political entities, utilities, railroads, etc. in a different manner. The extent to which designers or constructors can facilitate third-party agreements is the basis for the advantages and disadvantages of each delivery method.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ The use of complete plans and prescriptive specifications facilitates third-party agreements.	❒ Expediting third-party agreements in the DBB process can be cumbersome if it is required.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
❒ Construction managers can help facilitate third-party agreements.	✓ Construction managers typically do not guarantee costs involved with obtaining third-party agreements or which stem from problems with third-party agreements.

DESIGN-BUILD	
Advantages	Disadvantages
❒ Design-builders can use innovative methods to assist in obtaining third-party agreements.	❒ Some third-party agencies can have codes that negate the use of DB thereby excluding the DB method from consideration (see Step 3 Review Go/No-Go Decision Points). ✓ Design-builders typically do not guarantee costs involved with obtaining third-party agreements or which stem from problems with third-party agreements.

Table H-13 (D-12): Third-Party Agreement Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
12. Third-Party Agreement	●	o	o	x

Comments: BATA feels that DBB is the most effective delivery method for incorporating third-party requirements prior to construction start. Historically, the City of Big Apple agencies and utilities expect to have the ability to review and approve 100% designs prior to construction, and CMR and DB do not allow for this. The City of Big Apple agencies and utilities could impose additional requirements after award of a DB contract or after negotiation of a GMP in a CMR contract, thereby increasing cost and time or creating disputes about extra time and extra money.

Public Policy/Regulatory Issues

13) Competition

Each delivery method may affect the level of competition. This concerns the evaluation of facilitating effects of each method on competition. Alternative project delivery methods allow agencies to package projects in sizes that can effectively enhance or reduce competition.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ Owner benefits from large pool of potential bidders and a high level of competition.	✓ There are issues that follow low-bid procurement, such as a higher probability of requests for change orders, disputes, and claims.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Qualifications-based selection factors can be applied to select only the most highly qualified construction managers.	✓ Presence of a constructor early in the project may give the owner less competitive leverage when pricing the construction.

DESIGN-BUILD	
Advantages	Disadvantages
✓ Qualifications-based selection factors can be applied to select only the most highly qualified design-builders.	❒ Proposal package size and bid preparation costs can decrease the number of qualified bidders. ❒ Opposition from public sector employees, unions, or other interested parties can exclude the DB method from consideration (see Step 3 Review Go/No-Go Decision Points).

Table H-14 (D-13): Competition Advantages/ Disadvantages Summary

	DBB	CMR	DB	DBOM
13. Competition	o	o	●	x

Comments: BATA felt that the qualifications-based selection, plus good competition on previous DB projects make it the most appropriate project delivery method. DBB and CMR were also less appropriate because of the applicable disadvantages.

14) Disadvantaged Business Enterprise (DBE) Impacts

The extent to which the delivery methods can be used to promote participation of disadvantaged businesses forms the advantages and disadvantages of this issue.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ Agencies can include DBE requirements in both design and construction requirements. ✓ DBE involvement is known at time of award for design and construction.	❒ Low-bidding environment may harm future viability of DBE companies.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Agencies can include DBE requirements in both design and construction requirements. ✓ DBE involvement is known at time of award for design and construction.	❒ Due to the phased nature of CMR contracts, the final DBE involvement may not be known until the project is ultimately completed.

DESIGN-BUILD	
Advantages	Disadvantages
✓ Agencies can include DBE requirements in the RFP for design and construction requirements.	❒ Owners can set DBE requirements, but because all subcontractors are not known at the time of award, there is a risk that design-builders may not achieve the DBE goals they specify in their proposals.

Table H-15 (D-14): DBE Impacts Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
14. DBE Impacts	o	o	o	x

Comments: BATA felt that project delivery method has no bearing on setting and enforcing DBE goals and participation.

15) Labor Unions

The choice of delivery method may have an impact on labor usage and hence labor union issues. These issues can be both internal to the transit agency as well as external with its contractors.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ The DBB process is well established, so there is generally no fundamental opposition from unions.	❒ None.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Similar to DBB, there is generally no fundamental opposition from unions.	✓ Construction managers do not generally guarantee prices if there are issues with labor unions.

DESIGN-BUILD	
Advantages	Disadvantages
❒ None.	❒ Opposition from public design unions can exclude the DB method from consideration (see Step 3 Review Go/No-Go Decision Points). ❒ Design-builders do not generally guarantee prices if there are issues with labor unions.

Table H-16 (D-15): Labor Unions Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
15. Labor Unions	⊙	○	⊙	X

Comments: BATA felt that CMR is least appropriate because union issues may make it difficult to negotiate a GMP.

16) Federal/State/Local Laws

Use of some delivery methods may not be allowed for transit agencies due to state or local laws. Some of the states mandate that the transit agencies go through several steps before being allowed to use an alternative delivery method. The level of difficulty of using a delivery method from a legal standpoint constitutes the advantages and disadvantages of this issue.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ All states are authorized to use DBB.	❒ None.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Some states allow more flexible procurement regulations with CMR, which can be advantageous in appropriate situations to expedite project development.	❒ Some state agencies are not authorized to use CMR or need to get extra approvals (see Step 3 Review Go/No-Go Decision Points).

❒

DESIGN-BUILD	
Advantages	Disadvantages
✓ Some states allow more flexible procurement regulations with DB, which can be advantageous in appropriate situations to expedite project development.	❒ Some state agencies are not authorized to use DB or need to get extra approvals (see Step 3 Review Go/No-Go Decision Points).

Table H-17 (D-16): Federal/State/Local Laws Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
16. Federal/State/Local Laws	o	o	o	x

Comments: BATA felt that all delivery methods were equally appropriate. It was assumed for this hypothetical project that CMR and DB are not prohibited by Big Apple, state, or federal laws and regulations.

17) FTA/EPA Regulations

The extent to which the various delivery methods can facilitate FTA requirements and EPA regulations given the unique project characteristics constitutes the advantages and disadvantages of this issue.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ Familiarity of agencies with this method facilitates permit and funding process.	❒ The final cost and schedule are established long after the Full Funding Grant Authorization (FFGA), which can be problematic if FFGA cost and schedule estimates are not met.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
❒ Construction managers can help facilitate the environmental process.	✓ The use of a GMP with separate design and construction packages can result in a final cost and schedule confirmation long after the FFGA.

DESIGN-BUILD	
Advantages	Disadvantages
❒ FTA has gained some experience and has modified its procedures to use DB. ✓ Cost and schedule are fixed near the FFGA.	❒ The design required to acquire environmental permits before a design-builder is hired may cause delays and negate some of the advantages of the DB method.

Table H-18 (D-17): FTA/EPA Regulations Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
17. FTA/EPA Regulations	●	○	⊙	X

Comments: BATA felt that DBB was most appropriate because of it being so familiar with the FTA and EPA processes applied to DBB projects. BATA felt CMR was the least appropriate because of the potential difficulty of reaching a negotiated GMP well after the FFGA amount is set, with unknown subsurface conditions in this underground tunnel project.

18) Stakeholder/Community Input

This issue addresses the opportunity for stakeholder involvement afforded by the delivery methods.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ Separate design and construction phases give an opportunity to get stakeholders' inputs before the commencement of construction.	❒ The opportunity for stakeholder changes in design can cause delays in the project.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ The construction experience of the construction manager can help facilitate stakeholder input.	❒ Stakeholder input can make GMP negotiation troublesome if not managed correctly.

DESIGN-BUILD	
Advantages	Disadvantages
✓ The owner can require the DB contractor to include a public information and outreach program to facilitate communities' inputs. ❒ Design-builders can be innovative in helping gain community involvement.	❒ Any change because of community inputs after the issuance of RFP can be costly.

Table H-19 (D-18): Stakeholder/Community Input Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
18. Stakeholder/Community Input	o	o	o	x

Comments: BATA felt that project delivery method had no bearing on stakeholder/community input, since it is always BATA's responsibility (not the designer's and not the contractor's) to ensure appropriate stakeholder/community input, regardless of project delivery method.

Lifecycle Issues

19) Lifecycle Costs

Delivery methods can influence costs in the operation and maintenance phase. This issue focuses on the opportunities or barriers that each delivery method provides with regard to lifecycle costs.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ The agency can control lifecycle costs through completed design and performance specifications.	❒ The DBB system allows for little constructor input into lifecycle costs.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ CMR has all benefits of DBB, plus the agency can leverage construction manager's input into lifecycle costs.	❒ If lifecycle performance criteria are not well understood during the development of the GMP, lifecycle issues may be difficult to incorporate into the final product.

DESIGN-BUILD	
Advantages	Disadvantages
✓ The agency can use performance criteria to set lifecycle performance standards and rely on design-builder innovation to achieve these standards.	✓ If lifecycle performance criteria are not well understood at the procurement stage, they will not be incorporated into the DB contract.

Table H-20 (D-19): Lifecycle Costs Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
19. Lifecycle Costs	●	●	○	X

Comments: BATA felt that DB was less appropriate because of the loss of control of design detail after 30%.

20) Maintainability

There can be advantages and disadvantages to each delivery method with regard to how maintainability is achieved. This issue describes these advantages and disadvantages as they relate to the owner's ability to specify quality and ease of maintenance.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ The opportunity to view completed plans before award allows agencies to review maintenance issues in designs.	❒ There is little opportunity for constructors to have input into maintenance issues.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ CMR has all the benefits of DBB, plus the agency can leverage construction manager's input into maintenance issues.	❒ If maintainability issues are not well understood during the development of the GMP, they may be difficult to incorporate into the final product.

DESIGN-BUILD	
Advantages	Disadvantages
✓ The agency can emphasize maintainability issues through performance criteria and best-value award factors.	❒ If maintainability issues are not well understood at the procurement stage, they will not be incorporated into the DB contract.

Table H-21 (D-20): Maintainability Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
20. Maintainability	o	o	o	x

Comments: BATA felt that project delivery method had no bearing on maintainability. DBOM would clearly be the most appropriate, but it was eliminated from consideration earlier in the analysis.

21) Sustainable Design Goals

Sustainable design is becoming ever more important in achieving overall sustainability goals for projects. The effect of delivery method in facilitating the process of implementing sustainability issues in the design is the focus of this issue.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ Agencies can work with designers to incorporate sustainable designs into complete designs.	❒ The process provides little opportunity for constructability reviews to ensure that sustainable designs can be constructed efficiently and are not cost prohibitive.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ CMR has all benefits of DBB, plus the agency can leverage construction manager's input into sustainable design issues.	❒ The use of separate bid packages can create barriers in the integration of sustainable solutions if not approached correctly.

DESIGN-BUILD	
Advantages	Disadvantages
❒ The agency can emphasize sustainable design issues through performance criteria and best-value award factors. ✓ Integration of the design and construction team can enhance constructability of designs.	✓ If sustainable design issues are not well understood at the procurement stage, they will not be incorporated into the DB contract.

Table H-22 (D-21): Sustainable Design Goals Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
21. Sustainable Design Goals	⭘	⭘	○	X

Comments: BATA felt that DB was less appropriate because of the loss of control of design detail after 30%.

22) Sustainable Construction Goals

Sustainable construction is an important vehicle for achieving overall sustainability goals as well. The effect of delivery method in facilitating the process of sustainable construction is the focus of this issue.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ Prescriptive specifications can be used to define sustainable construction practices prior to design.	❒ There is little opportunity or incentive for constructor to do more than what is specified in terms of sustainable construction practices. ❒ Agencies can assume liability when prescribing construction methods.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ The agency can leverage construction manager's input into sustainable construction issues.	❒ The use of separate bid packages can create barriers in the integration of sustainable solutions if not approached correctly.

DESIGN-BUILD	
Advantages	Disadvantages
❒ The agency can emphasize sustainable construction issues through performance criteria and best-value award factors. ✓ Integration of the design and construction team can enhance the use of sustainable construction practices.	✓ If sustainable construction issues are not well understood at the procurement stage, they will not be incorporated into the DB contract.

DESIGN-BUILD-OPERATE-MAINTAIN	
Advantages	Disadvantages
❒ DBOM contractors can realize economic returns for sustainable designs since they have an inherent bias toward minimizing operations and maintenance lifecycle costs.	❒ If sustainable construction issues are not well understood at the procurement stage, they will not be incorporated into the DBOM contract.

Table H-23 (D-22): Sustainable Construction Goals Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
22. Sustainable Construction Goals	⊙	⊙	○	X

Comments: BATA felt that DB was the least appropriate because of the inherently more hands off/turnkey nature of DB.

Other Issues

23) Construction Claims

The effect of each delivery method in exposing the agency to potential conflicts and claims is addressed under this issue.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ DBB has well-understood legal precedent for construction claims.	✓ DBB historically has the highest occurrence of claims and disputes, which often occur in the areas of authority, responsibility, and quality. ✓ The low-bid environment can provide incentives for a constructor to file claims—particularly if any ambiguity in plans exists.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Having the constructor on the team early during design can lessen the likelihood for disputes and claims regarding designs.	✓ Since design and construction contracts are separate, the potential for disputes and claims regarding design still exists. ✓ If multiple bid packages are not managed correctly, the coordination of these bid packages can result in claims.

DESIGN-BUILD	
Advantages	Disadvantages
✓ The single source for design and construction eliminates claims for design errors or omissions from the agency's perspective.	✓ There is potential for claims with regard to scope definition if the form of the DB contract is not well understood.

Table H-24 (D-23): Construction Claims Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
23. Construction Claims	○	◘	●	X

Comments: BATA felt that DB is the most appropriate method because of the elimination of finger pointing between designer and constructor. CMR was felt to be more effective than DBB because of the dialogue and working relationship established with the constructor during the design phase.

24) Adversarial Relationship

The extent to which a delivery method can prevent adversarial relationships on the project team varies depending upon the nature of the project and the owner's experience with the delivery methods.

DESIGN-BID-BUILD	
Advantages	Disadvantages
✓ Roles and responsibilities in DBB contract are very well understood in the industry.	✓ DBB can create an adversarial relationship between the parties, primarily between the owner and construction contractor.

CONSTRUCTION MANAGEMENT AT RISK	
Advantages	Disadvantages
✓ Inclusion of the construction manager in the design process can align team members and lessen adversarial relationships.	✓ Negotiation of GMP can create an adversarial situation if the process is not well understood.

DESIGN-BUILD	
Advantages	Disadvantages
✓ Inclusion of the designer and constructor on the same team can lessen adversarial relationships.	✓ Due to the loss of control over the details of design, DB requires a high level of trust between the owner and design-builder. Without this trust, design-build can become adversarial.

Table H-25 (D-24): Adversarial Relationship Advantages/Disadvantages Summary

	DBB	CMR	DB	DBOM
24. Adversarial Relationship	o	●	o	x

Comments: BATA felt that CMR was most advantageous because of the ability to work with and establish a mutually beneficial relationship with the CMR during design.

Step 5. Choose the Most Appropriate Project Delivery Method

Steps 1 through 4 of the process provide all the individual pieces of information necessary to make a project delivery decision. The final step involves combining this information into a final comprehensive format that will aid in the decision. Table D-25 was used to summarize the advantages and disadvantages. The summary ratings for each of the 24 issues were transferred into the table as follows.

Table H-26 (D-25): Project Delivery Method Advantage/Disadvantage Summary

	DBB	CMR	DB	DBOM
Project Level Issues Rating				
1. Project Size	◉	◉	◉	X
2. Cost	○	◉	●	X
3. Schedule	○	◉	◉	X
4. Risk Management	◉	●	◉	X
5. Risk Allocation	◉	◉	◉	X
6. LEED Certification	◉	◉	◉	X
Agency Level Issues Rating				
7. Agency Experience	◉	○	◉	X
8. Staffing Required	◉	◉	●	X
9. Staff Capability	●	○	◉	X
10. Agency Goals and Objectives	◉	◉	◉	X
11. Agency Control of Project	◉	◉	○	X
12. Third-Party Agreement	●	◉	◉	X
Public Policy/Regulatory Issues Rating				
13. Competition	◉	◉	●	X
14. DBE Impacts	◉	◉	◉	X
15. Labor Unions	◉	○	◉	X
16. Federal/State/Local Laws	◉	◉	◉	X
17. FTA/EPA Regulations	●	○	◉	X
18. Stakeholder/Community Input	◉	◉	◉	X
Life Cycle Issues Rating				
19. Lifecycle Costs	●	●	◉	X
20. Maintainability	◉	◉	◉	X
21. Sustainable Design Goals	◉	◉	○	X
22. Sustainable Construction Goals	◉	◉	○	X
Other Issues Rating				
23. Construction Claims	○	◉	●	X
24. Adversarial Relationships	◉	●	◉	X

Key: ● Most appropriate delivery method
◉ Appropriate delivery method
○ Least appropriate delivery method
X Not Applicable (discontinue evaluation of this method)

In following the methodology, the project goals were revisited to determine if any of the project delivery methods stood out from the others when focusing on the issues (out of the 24 issues) most associated with the project goals that were established in Step 2. The project goals were the following:

1. Deliver project at or below budget (budget will be established at 30% design)
2. Optimize project schedule (escalation and project overheads are significant cost factors)

3. This must be an affordable, appealing mode of transportation for riders (revenue stream)
4. Minimize disruption to the public/abutters
5. All facilities (tunnels, systems, stations, buildings) must be simple and sustainable with minimized O&M requirements and costs

DB seemed to have a slight advantage when considering Goals 1 and 2—meeting project cost and optimizing schedule, respectively (Issues 2 and 3 in Table D-25). Nonetheless, there was not enough of a distinction to compel BATA to conclude that DB was clearly the most appropriate project delivery method. None of the project delivery methods had an advantage when considering Goal 3—delivering an affordable, appealing mode of transportation for riders. DBB seemed to have a slight advantage when considering Goal 4—minimizing disruption to the public/abutters (Issues 12 and 18 in Table D-25). However, again, there was not enough of a distinction to compel BATA to conclude that DBB was clearly the most appropriate project delivery method. DB seemed to be the least appropriate project delivery method for achieving Goal 5—a sustainable system with minimized O&M requirements and cost (Issues 19, 20, 21, and 22 in Table D-25). However, it should be noted that DB scored poorly on Goal 5 (which might be considered as the least important goal). Accordingly, it was then concluded that DBB, CMR, and DB should all be analyzed using the Tier 2 approach.

Step 6. Document Results

(Note: this executive summary was developed as part of Step 6 in the Tier 1—Analytical Delivery Decision Approach. When analyzing an actual project, this executive summary should be placed at the beginning of the Tier 1 analysis report. Since this is merely an example of how to use the Tier 1 approach on a hypothetical project, the following brief executive summary will be left in this location.)

Executive Summary

The Big Apple Transportation Authority (BATA) used the Tier 1—Analytical Delivery Decision Approach to determine if there was a most appropriate project delivery method to use for its $1Billion, Big Apple bus rapid transit tunnel project. The project delivery methods analyzed were DBB, CMR, DB, and DBOM. The Tier 1 approach was followed step by step, and each step of the analysis was recorded and summarized in the following report. The Tier 1 analysis eliminated DBOM as a viable project delivery method because BATA performs all operations and maintenance functions with its internal union work forces, thereby precluding any outsourcing of operation and maintenance functions.

At the conclusion of the Tier 1 analysis, DBB, CMR, and DB were all deemed viable project delivery methods for the project, with no single delivery method being clearly distinguished as the most appropriate. Although no single delivery method was chosen, the analysis helped BATA to clearly recognize the following points:

1. BATA was most comfortable with the DBB project delivery method since nearly all of its projects have been executed using this delivery method, and its staff is fully familiar with this delivery method.

2. BATA was concerned about being able to negotiate a Guaranteed Maximum Price (GMP) with a CMR contractor because of the fact that this was an underground (tunnel) project, and it would be difficult to get a CMR to agree to a reasonable GMP because of the inherent risk of unknown subsurface conditions.

Tier 2—Weighted-Matrix Delivery Decision Approach (Hypothetical Project)

Following application of the Tier 1 approach, BATA proceeded to the Tier 2—Weighted-Matrix Delivery Decision Approach to determine if there was a most appropriate project delivery method for its $1Billion, Big Apple bus rapid transit tunnel project.

Step 1. Define Selection Factors

For the purposes of this hypothetical test of the Tier 2 methodology, the analysis was recorded by using the tables from Appendix E. BATA began its Tier 2 analysis by revisiting the project goals, major challenges, and main identified sources of risk developed in the Tier 1 analysis. These are all listed below.

Project Goals

1. Deliver project at or below budget (budget will be established at 30% design)
2. Optimize project schedule (escalation and project overheads are a significant cost factor)
3. This must be an affordable, appealing mode of transportation for riders (revenue stream)
4. Minimize disruption to the public/abutters
5. All facilities (tunnels, systems, stations, buildings) must be simple and sustainable with minimized O&M requirements and costs

Major Challenges:

- Congested urban environment
- Penetrating/relocating existing subsurface utilities
- Removal and disposal of excavated materials
- Top-down access for cut & cover station construction
- Construction contract packaging
- Construction contract interfaces
- Third-party abutters
- Big Apple Transportation Department (BATD)—traffic control, detours, access to city streets
- Construction of boat section portals on city streets
- Limited construction laydown area available
- Stabilization and underpinning of old, existing tunnels

Main Identified Sources of Risk:

- Uncertainty of subsurface geotechnical conditions

- Third-party abutter impacts
- Extremely narrow construction corridor
- Instability of old, existing tunnels
- Plan for removal and disposal of excavated materials
- BATD Cooperation—traffic restraints, detour approvals
- Tunneling under active, congested urban environment

Upon re-examination of these items, and in light of the issues reviewed and examined during the Tier 1 analysis, BATA determined that it should expand its project goals from five goals to seven goals and that it should also reprioritize its goals. A new list of refined project goals and issues, in priority order, is as follows.

Refined Project Goals & Issues

1. Deliver project at or below budget
2. Optimize project schedule (escalation is a huge cost factor)
3. Minimize disruption to the public/abutters
4. Effectively manage the uncertainty of subsurface conditions
5. Effectively manage the impacts of third-party abutters during planning, design, and construction
6. All facilities (tunnels, systems, stations, buildings) must be simple and sustainable with minimized O&M requirements and costs
7. This must be an affordable, appealing mode of transportation for riders

Step 2. Weight Selection Factors

Each of the key goals and issues developed and prioritized in Step 1 was then weighted as follows. These seven items were then referred to as "selection factors."

Table H-27– Weighting the Selection Factors

Weight	Goal/Issue
25	Deliver project at or below budget
20	Optimize project schedule
16	Minimize disruption to the public/abutters
14	Effectively manage the uncertainty of subsurface conditions
12	Effectively manage the impacts of third-party abutters during planning, design, and construction
8	All facilities (tunnels, systems, stations, support buildings) must be simple and sustainable with minimized O&M requirements and costs
5	This must be an affordable and appealing mode of transportation for riders (revenue stream)
100	**Total**

Step 3. Score Project Delivery Methods

The following scale (excerpted from Appendix E) was then used to provide a score for each project delivery method as it related to each of the seven factors.

Table H-28 (E-1) - Project Delivery Scoring Scale (adapted from Saaty 1990)

SCORE	DEFINITION
10	The evidence that the delivery method positively aligns with the project objective or issue is of the highest possible order of affirmation.
8	The delivery method strongly aligns with the objective or issue and is demonstrated in practice. There is a slight risk that the objective or issue may not be beneficial.
6	Experience and judgment point to the delivery method strongly aligning with the objective or issue. There is a mild risk that the objective may not be beneficial.
4	Experience and judgment slightly points to the delivery method aligning with the objective or issue. There is a strong risk that the objective will be negatively affected.
2	There is little benefit to applying the delivery method for this goal or objective. There is a strong likelihood that the object will not be achieved.
9,7,5,3,1	Intermediate values between two adjacent judgments.

The seven factor scores and weights were then combined in Table E-2. Weighted scores in Table E-2 were calculated by multiplying the factor weights by the score for each delivery method.

Table H-29 (E-2) - Weighted-Matrix Template

		DBB		CMR		DB	
Selection Factor	**Factor Weight**	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Factor 1 Deliver project at or below budget	25	3	75	6	150	9	225
Factor 2 Optimize project schedule	20	4	80	6	120	8	160
Factor 3 Minimize disruption to the public / abutters	16	5	80	5	80	5	80
Factor 4 Effectively manage the uncertainty of subsurface conditions	14	6	84	3	42	9	126
Factor 5 Effectively manage the impacts of third-party abutters	12	6	72	8	96	3	36
Factor 6 All facilities must be simple and sustainable with minimized O&M requirements and costs	8	7	56	7	56	3	24
Factor 7 This must be an affordable and appealing mode of transportation for riders	5	7	35	7	35	3	15
Total Score	100		**482**		**579**		**666**

Step 4. Choose Most Appropriate Project Delivery Method

The weighted scores from each of the seven factors were then totaled at the bottom of Table E-2 for each of the three project delivery methods. DB had the highest score, 666; CMR had a score of 579; and DBB had the lowest score, 482. The DB score of 666 is significantly higher than the score of 482 for DBB. DBB was therefore eliminated as a viable project delivery method. The DB score of 666 is also higher than the score of 579 for CMR, so BATA selected DB as the most appropriate project delivery method. BATA has also successfully delivered other DB projects and considers the potential schedule savings presented by the DB project delivery method as a means of significant cost savings on this large project because of the magnitude of the cost of escalation and project overheads associated with a $1Billion project. BATA remained concerned about its ability to negotiate a

reasonable GMP with a CMR because of the inherent risk presented by the unknown subsurface conditions associated with this tunnel project.

Step 5. Document Results

The results of the Tier 2—Weighted Matrix Delivery Decision Approach are documented in the preceding write-up and tables. Once again, this was a hypothetical project used to test and demonstrate the methodology. When analyzing an actual project, the final Project Delivery Decision Report should also contain a detailed documentation of the reasoning that was used to assign each criterion weight and project delivery score.

Conclusion

In the case of this hypothetical project, at the end of the Tier 2 analysis, DBB was clearly eliminated as a potential project delivery method. DB scored higher than CMR. Working through the Tier 1 and Tier 2 approaches enabled BATA to develop a clear sense of what issues and goals were most important to the success of the project. At the end of the Tier 2 analysis, it was this clear sense of the issues that allowed BATA to select DB over CMR as the most appropriate project delivery method. The key issues leading BATA to this decision, in addition to the difference in total scores, were (1) BATA has successfully delivered other DBB; (2) potential schedule savings presented by the DB project delivery method represent significant cost savings on this large project because of the magnitude of the cost of escalation and project overheads associated with a $1Billion project; and (3) BATA remained concerned about its ability to negotiate a reasonable GMP with a CMR contractor because of the inherent risk presented by the unknown subsurface conditions associated with this tunnel project.