12 Conclusions and Next Steps

12.1 Introduction

The RMRA Feasibility and Business Plan study offers a prime opportunity to enhance Colorado's transportation network. Implementation of a high-speed rail system in the I-25 and I-70 corridors would enhance mobility and provide additional needed transportation capacity in the state at a time of rising gas prices and increasing congestion. It would be a strong economic engine, both supporting and generating economic growth and transit-oriented development in the towns and cities connected to the system.

The study has identified the market for high-speed passenger rail service in Colorado, and shown the potential for a linked and fully integrated I-70 and I-25 high-speed rail system. The representative routes evaluated in the I-25 and I-70 corridors make extensive use of existing rail and highway rights-of-way, but greenfield options have also been developed where they can be shown to improve the performance of the system. The analysis has shown that on its own the I-25 corridor can sustain a 110-mph diesel option, but if I-25 were linked to a I-70 DIA to Eagle Airport corridor, the combined corridors would be capable of supporting 220-mph electric rail technology that could provide a single-seat ride.

The analysis has focused on technologies that could be expected to be ready for operational implementation by 2020. For any Colorado high-speed rail system, a critical factor in the system's performance is the gradients associated with the I-70 corridor, and this study has identified ways of connecting the I-70 communities using 4 percent grade segments that are easily climbed by modern high-speed trains.

In future analysis further consideration must be given to the I-70 corridor route, which has three locations with 7 percent grades. While modern high powered passenger and maglev trains can climb these grades, albeit at reduced speeds, consideration should be given to using more tunnels (at higher cost) to reduce the required climbing requirement of the trains and provide better performance in terms of speed and time. The most critical gradients to be considered are those 7 percent sections on the eastern face of the Rockies between Golden and Silver Plume. In the FRA Developed Option route, 4 percent grade segments have already been developed for crossing Loveland and Vail passes which make them less critical than the mountain areas between Golden and Silver Plume.

For evaluating the alternatives, FRA efficiency criteria were used and the FRA Developed Option, as well as both the 220-mph and 150-mph truncated network alternatives satisfied both the financial and economic criteria. This showed that potential exists for a public-private partnership similar to those proposed in California and in Florida for implementing the system. While Federal funding

programs are still being developed, it is clear that a combination of state, federal and public-private funding can be used to develop the system. Federal grants of 50-80 percent for infrastructure are anticipated, particularly if tax credit funding is used to expand federal financing capability.

12.2 Statewide Mobility

The RMRA statewide passenger rail system would significantly improve regional mobility in Colorado by linking many of the state's largest communities and attractions. While the initial system would connect well over 85 percent of the state's population, its eventual build out would connect over 95 percent.

An extensive public outreach program has been initiated in support of this study, and the analysis has been sensitive to the key concerns identified as a result of the study. Potential station locations for the proposed system were identified in conjunction with local communities and corridor representatives.

12.3 Environmental Benefits

While the proposed Colorado passenger rail system has not been subject to a full environmental analysis, it is clear that the system would provide many economic and environmental benefits. These include reduced automobile use, and specifically resource savings in terms of emissions, noise, safety, gas reductions, highway infrastructure, and travel time savings both for individuals diverting from the automobile, as well as those continuing to drive. High-speed rail would also have a positive impact on the region's land use encouraging higher density and proximity of development to the high-speed rail stations. In an environmentally sensitive corridor these benefits are critically important.

12.4 Challenges

The development of a Colorado high-speed passenger rail system faces significant challenges. These include:

- **Public Funding:** To overcome the physical constraints of the I-70 corridor, the cost of construction in the I-70 corridor would be very significant. The I-70 corridor would cost three times that of the I-25 corridor. However, the I-70 corridor is a very powerful economic engine for the Colorado economy. Given its highly sensitive environment, investment in high-speed rail makes sense in both financial and economic terms. Critical elements in developing a funding plan would be:
  - The role of the Federal Government in providing Infrastructure Grants
  - The role of the State in developing match money and public-private partnerships to help finance, construct, and operate the system.
- **Freight Railroads:** A critical component of the Colorado Passenger Rail System is the potential use of freight railroad rights of way in the I-25 corridor, as well as for supporting future western extensions. This is clearly viewed as a major risk factor, as both the state and

freight railroads need to agree on what can be done and its costs. CDOT has carried out studies with the freight railroads on the potential for a rail bypass around Denver, and there are indications that the railroads would be willing to negotiate with CDOT. There are significant costs for both using and not using the freight railroad right-of-way, and these need to be evaluated carefully in a Cost Benefit Analysis considering both public and private benefits. There is both significant public and political opposition to and support for a rerouting of the freight lines.

- **Technology:** The operation of a high-speed rail system in the mountain corridor would be unique in the world, so no existing or off-the-shelf train in use today can reasonably be expected to meet all of Colorado's requirements. However, while the 220-mph Electric Rail technology evaluated in this study with its combination of components for speed, tilting, and 7 percent grade-climbing ability at 60-mph is not in operation anywhere in the world today in this configuration, all of the features or components needed to create such a train have been proven and are operational in revenue service in numerous applications. The 300-mph maglev technology is also not in use on 7 percent grades today, although its manufacturer provides performance specifications for vehicle operation on grades of up to 10 percent.

  Since the system will require a minimum of 5 to 7 years for additional study, environmental clearance and engineering design, it is likely that vehicle technologies will continue to evolve and improve. Off-the-shelf Electric Multiple Unit trains are capable of operating on 7 percent grades at 40-mph and on 4 percent grades at more than 80-mph. To mitigate risks associated with the potential need for equipment modifications, the FRA Developed Option sought to limit grades to 4 percent so only a few 7 percent segments remain. (See Appendix H) This allows the use of off-the-shelf trains since exposure to schedule impacts would be limited to only a few short sections. There is also an equipment risk associated with the potential need for FRA compliance modification. Current very high-speed trains from Europe and Japan are not FRA compliant and while this issue is likely to be addressed within the 5 to 7 year time frame cited above, it is currently a risk factor. However, this risk was addressed in Section 10.6 by development of additional route and infrastructure options that completely separate passenger operations from freight trains.

12.5 FRA Criteria for Corridor Designation

In answer to the six FRA corridor feasibility factors that were identified at the outset of this study:

- **Speed:** Both the I-70 and I-25 corridors would include many segments where more than 90-mph speeds would be attainable. The top speed achieved by the FRA Developed option would be 220-mph in several sections of the proposed I-25 South greenfield alignment. The I-25 North corridor is not quite capable of 220-mph due to curves in the highway alignment and frequent stops, but it is capable of speeds consistently exceeding 110-mph and could reach 200-mph in some places. Because of the development of the unconstrained alignment option for I-70, several segments of the proposed I-70 corridor are straight enough to support 90-mph or higher speed running. The segment from DIA to Denver to Golden supports speeds in excess of 150-mph and a top speed of 220-mph. Much of the I-70 mountain

corridor despite its poor geometrics and steep grades could operate faster than 90-mph, leading to an average speed of 75-mph from DIA to Eagle Airport. Speeds exceeding 150-mph could be reached west of Copper Mountain on the new alignment to Pando.

- **Ridership:** Both the I-70 and I-25 corridors have strong ridership potential which would be capable of supporting at least 16-20 daily round trips on each corridor, and even more service as traffic grows in the future. Ridership demand is strong enough to support a double tracked railroad solution on all corridors.
- **Maximum Speed Percentage:** Because of the high power requirement for operating on 4-7 percent gradients, the proposed Colorado trains would have a very high theoretical maximum cruise speed of 220-mph on level track. On I-25 about 20 percent of the route can operate at 220-mph but only 5 percent on I-70. On both corridors however, much of the route is operable at more than 90-mph, despite severe curvature and/or gradients.
- **Non-Rider Benefits:** As shown in Exhibit 10-9, the projected external mode benefits to non-riders are substantial and equate to a quarter of the total benefit from this project. This shows that the proposed rail system will be able to divert enough auto traffic to noticeably reduce highway congestion, so that even non-users will benefit from the system.
- **Financial Support:** This study, like many other high-speed rail projects, has assumed a 70-80 percent federal match with a 20-30 percent local contribution. It can be seen in Exhibit 10-9 that the present value of the operating surplus is $13.449 billion revenue minus $7.083 billion operating cost or $6.366 billion. This is 42 percent of the capital cost of the system. Private operators would demand a higher rate of return on their investment than would a public source; nonetheless in a public-private partnership, it is likely that any of the 220-mph electric rail options could raise more than 20 percent of their needs from private sector funding sources. The operating surpluses of the system could likely be used to service revenue bonds that could be used to pay the local matching share of capital.
- **Freight Railroad Cooperation:** Even though the FRA Developed option relies heavily on greenfield alignments, it still uses freight railroad right-of-way from Littleton through downtown Denver past DIA airport to the E-470 on the north[1], and from Dowd Junction to Eagle Airport. As a result, one of the largest potential risk factors for the study is the role that the freight railroads are likely to play. However, at least one of the railroads has shown a great interest in the Colorado DOT "R2C2" initiative. By reducing freight traffic on some existing rail lines the "R2C2" initiative could help clear the way for the implementation of passenger rail. Alternatively, the use of elevated structures or alternative alignments assessed in Section 10.6 could alleviate this requirement and mitigate the risk associated with sharing freight rail rights of way.

[1] This alignment would bring I-25 service from Pueblo and Colorado Springs first to downtown Denver and then continue on to DIA.

12.6 Key High Speed Rail Feasibility Study Findings

Under the direction of the Rocky Mountain Rail Authority Board of Directors and its designated Feasibility Study Steering committee, this study has assessed a wide range of alternatives for developing a high-speed rail system in the I-25 and I-70 corridors of Colorado. Key findings of the study are:

- A Cost Benefit assessment of a wide range of technology options has been performed using USDOT / FRA criteria. Several alternative options developed in the RMRA study pass the FRA tests for both financial and economic feasibility and would provide significant benefits to the I-25 and I-70 corridors, the State of Colorado, and to the US economy as a whole. These alternatives provide a strong case for building high-speed rail in both the I-25 corridor between Pueblo and Fort Collins and in the I-70 corridor between DIA and Eagle Airport.
- Economic feasibility as defined by the FRA proved to be the most difficult criteria for the RMRA study alternatives to overcome. The 220-mph Electric Rail technology option had the highest economic feasibility score of all alternatives evaluated in the RMRA study with a Cost Benefit ratio of 1.28, and was selected for more detailed evaluation as the FRA Developed Option as a result. Further fine-tuning applied to the FRA Developed Option further improved the Cost Benefit result to a comfortable 1.49.
- Strongest ridership in the Colorado system would occur when a "single seat" ride from I-25 communities to the mountain resorts is possible in both the summer and winter. This is because so many of the people who live along the I-25 front range use the I-70 resorts and facilities for recreation, creating a strong synergy between the two corridors. The avoidance of any requirement for transfers would be especially important to skiers and overnight travelers who may have extensive luggage and recreational equipment with them.
- In the I-25 corridor the strongest technologies were the 220-mph and 150-mph Electric Rail technologies, and the 110-mph Diesel Rail technology. Maglev systems were found to be significantly more expensive than Rail technologies in capital investment although the 300-mph maglev alternative would provide the highest ridership and best Operating Ratio numbers of all alternatives evaluated.
- Technology findings for the I-70 corridor demonstrate that 110-mph diesel could only be used west of Eagle Airport or west of Silverthorne, Dillon, and Frisco if the Tennessee Pass route via Pando rather than Vail Pass were adopted. From DIA to Eagle Airport only the Maglev and 220-mph electric rail technologies could be used, since the route options include 7 percent grade segments.
- Maglev can work in the I-70 corridor, but if used for the Colorado network (i.e. both I-70 and I-25 corridors) and along the same alignment, it would be almost twice the capital cost of a 220-mph electric rail system. It is worth noting however, that the cost of a Maglev alternative in the I-70 corridor is only slightly higher than the 220-mph rail alternative due the extensive tunneling and elevated structure required. In order to achieve FRA economic feasibility, a Maglev system selected for the I-70 corridor would need to be linked to a lower capital cost electric or diesel train in the I-25 corridor with a transfer for feeding passengers from the I-25 communities.

- The system would take 12 to 15 years to implement largely due to the extensive program development and environmental process required both under NEPA and by the state of Colorado. However the process could be expedited through the use of the Context Sensitive Solution process, which is standard practice today, by the Colorado Department of Transportation.
- The Implementation Plan for the FRA Developed Option using 220-mph electric rail technology was disaggregated into four implementation phases that spread the construction period over eight years. Given the sensitivity of the I-70 environment it is not surprising that this would be a lengthy process. Nonetheless, given the 2020 startup date now proposed by California High Speed Rail with a completed EIS, a 2025 target date for the Colorado system completion does not seem unreasonable.
- Rail connections to DIA will ensure the ability of tourists to reach key attractions along I-70 despite the growing difficulties due to growing I-70 highway congestion.
- Rail connections would support daily business, commuter and social travel in the I-25 corridor, and would also provide access to DIA and to day trip recreational destinations along I-70. Rail would make weekend trips to I-70 tourist attractions much quicker, safer and more affordable from all the communities along the I-25 corridor.
- The economic impact of developing the rail system would be considerable. It would generate significant construction jobs, permanent rail jobs, and many additional indirect jobs over the life of the project.
- Passenger rail service would spur economic growth activity, travel and tourism, property values, downtown redevelopment, and a tax base expansion due to the extra employment. The investment would make a positive contribution to the development of the national, state and local economies without being accompanied by any long-term subsidy burden.
- This study has concluded that there are financially and economically feasible alternatives for developing a high-speed rail system in Colorado.

12.7 Further Development of I-25 South Greenfield Options

This study assessed several route alternatives for the I-25 South corridor from Denver to Pueblo. Early in the study, a greenfield alignment was proposed as an alternative to using existing rail in the corridor. The original greenfield alignment used the former Rock Island right of way to regain access to the historical Colorado Springs train station downtown.

However, variants on this greenfield option were later considered as part of the Freight Rail Risk Assessment. This risk assessment developed alternatives to avoid or minimize the use of existing rail alignments through downtown Denver and Colorado Springs. In Colorado Springs a greenfield alignment was extended south past the Colorado Springs airport rather than using the existing rail right-of-way through downtown. In response to the risk assessment, representatives of El Paso County suggested further refined alignment options that are documented in Appendix I. It is recommended that these options be studied in subsequent phases of development of the Colorado high-speed rail system.

12.8 I-70 West Programmatic Environmental Impact Statement

The I-70 West Programmatic Environmental Impact Statement performed under direction of the Federal Highway Administration and the Colorado Department of Transportation is scheduled for a Record of Decision in 2011. Prior to the completion of this Feasibility study, the Colorado Department of Transportation and the Federal Highway Administration convened a group of 27 diverse stakeholders in 2008 (named the Collaborative Effort Group) to develop a consensus for the preferred alternative in the I-70 West PEIS study. The Collaborative Effort Group agreed upon a preferred alternative that includes an Advanced Guideway System (AGS) from Golden to Eagle County Airport as part of a joint highway and transit improvement solution for the I-70 mountain corridor. The AGS alternative contemplates an advanced fixed guideway transit technology such as magnetic levitation for traversing the corridor's difficult mountain terrain that would have greater performance capabilities than traditional steel wheel on steel rail technologies.

The I-70 Corridor Coalition and I-70 Collaborative Effort Group have recommended criteria, listed in Appendix J[2] for the implementation of an advanced transit system in the I-70 Mountain Corridor. It should be noted that the I-70 Collaborative Effort Group along with the I-70 Corridor Coalition have voiced a specific preference for an elevated low noise and environmentally friendly advanced fixed guideway system for the mountain corridor over a conventional on-grade rail solution.

Because of the I-70 coalition's strong preference for AGS rather than a rail solution, the initial screening of alternatives for this study developed a hybrid alternative "Option 9" in Section 9.4.2. This option coupled a 300-mph maglev solution in I-70 with a 110-mph rail service on I-25. This particular combination of technologies produced a marginally positive Cost Benefit ratio of 1.04, indicating the potential viability of this option. This result could perhaps have been improved by additional work for fine-tuning of that alternative.

However, the 220-mph electric rail technology for I-70 (with a Greenfield alignment in I-25) produced much stronger economic results, so in spite of the I-70 coalition's AGS preference, the RMRA Steering Committee selected an interoperable rail system for more detailed analysis as the FRA Developed option. As well as having a lower capital cost, a rail system could provide a single-seat ride between the I-25 and I-70 corridors. This would optimize the ability of I-25 to feed traffic into I-70, as opposed to a maglev solution that would require a transfer with luggage and recreational equipment. Since the FRA Developed option incorporates both I-25 and I-70, the increased ridership justifies the extra cost for a higher quality greenfield on I-25, instead of using an existing rail alignment.

[2] Source: http://rockymountainrail.org/documents/Criteria_Public.pdf

Although the I-70 Programmatic Environmental Impact Statement NEPA evaluation favors a completely elevated maglev solution in the I-70 corridor due to reduced environmental impacts over at-grade rail, FRA economic criteria favor development of a rail system for Colorado at this time. Given the demand for service and lower capital costs for at-grade construction, additional mitigation measures such as wildlife overpasses and underpasses[3] can be added to the at-grade rail solution at a very low cost.

It should be noted that the purpose of this study was only to determine whether any combination of technologies and routes could be found that would satisfy FRA's Economic criteria. That objective has been attained. This study has developed a clear economic justification for proceeding with a rail system solution. It has not however, ruled out the potential viability of an AGS solution in the I-70 corridor. However this study did clearly find that the economic viability of the I-70 corridor does depend on development of an effective I-25 feeder system, as well as direct DIA connectivity.

The ultimate selection of routes and technologies was not the objective of this Feasibility study. Rather, it was understood that the level of detailed analysis required to make an ultimate selection could not be performed within the limited scope and resources available to this study. Such decisions would be made in the context of a formal NEPA evaluation, such as that provided by the I-70 West Programmatic Environmental Impact Statement, where enough resources could be made available to support a sufficiently in-depth evaluation of not only the financial and economic, but also the environmental tradeoffs implicit in such choices.

12.9 Proposed Next Steps

Concurrent with the RMRA and Colorado DOT's continuing effort to broaden and strengthen support for the Colorado high-speed rail passenger system with citizens, local state and federal stakeholders, business community and regional transport authorities, there will be a need to advance the technical planning for the proposed system. This should include financial planning, development of public-private partnerships, and organization of the necessary institutional arrangements needed to secure funds for additional planning, environmental, and engineering work. This would include design and construction of infrastructure and equipment needed for implementation.

Next steps involve continued public outreach, environmental and engineering reviews and analysis, coordination with the railroads as needed, and attaining Federal and state support for the project.

Short-term actions should include:

- The development of a comprehensive Colorado State Rail plan, which is a prerequisite for funding eligibility under ARRA and PRIIA[4].
- Supply-side Economic Impact for identifying Joint Development opportunities, and the possibility for local and private matching funding contributions

[3] Highways through Habitats, *TR News #249*, Transportation Research Board, March-April 2007, page 14.
[4] ARRA: American Recovery and Reinvestment Act of 2009; PRIIA: Passenger Rail Investment and Improvement Act of 2008.

- Environmental Assessments
- Finance and Funding Plans
- Grassroots support for the project
- Discussions with freight railroads
- Further Alternatives Analysis
- Preliminary Engineering
- Generation of a performance matrix / specification to be discussed with potential system suppliers, in support of a Train Procurement Process

A possible means of advancing the Colorado passenger rail system would be through a program development process including environmental analysis, designed to be completed in two to three years while creating the potential to carry out Tier 2 Environmental Assessment (EA) or Environmental Impact Study (EIS) that is a key component of the project development process. This would provide:

- Delineation of "Purpose and Need" for the passenger rail system
- Alternatives Analysis of alternative feasible technology and route alternatives
- Development of institutional structure to handle corridor development
- Preliminary Engineering (up to 30 percent)
- Economic Impact Studies
- Identification of levels of environmental analysis, and initiation of tiered studies.

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