The maglev's diminishing prospects

A status update on the Baltimore-Washington maglev proposal, 17 months after the federal government halted its environmental review

BY OWEN KELLEY (okelley@gmu.edu), JANUARY 21, 2023

On November 14, 2022, a maglev representative spoke at NASA Goddard in Greenbelt, and he seemed inexplicably confident that the proposed maglev would be built between Baltimore and Washington. This blog post examines his statements for clues about why he was so confident. The maglev proposal has been stalled for more than a year.[1]

Back in August 2021, federal regulators paused the environmental review for the superconducting magnetic-levitation rail line that a private company wants to build between Baltimore and Washington, DC. Since then, federal regulators have not stated when they will restart the environmental review, giving the impression that the review might be permanently halted. Only if the federal review were restarted and favorably concluded, then the project would again be on track for possible construction approval and funding.[2]

Background

The November 14 presentation at NASA Goddard was sufficient to win over at least one audience member who had never heard

[1] November 14, 2022, presentation and other maglev news: *Greenbelt News Review* (December 1 and 15, 2022), front page. NASA Goddard Engineering Colloquium, https://ecolloq.gsfc.nasa.gov/. Over 60 people attended the Nov. 14, 2022, seminar by phoning in or using video-conferencing software. An additional dozen participants attended in person. Most of the in-person attendees were affiliated with Baltimore Washington Rapid Rail (BWRR) or Central Japan Railroad. The author attended in-person but is not affiliated with either company.

[2] August 25, 2021, pause on the FRA dashboard: https://www.permits.performance.gov/permitting-projects/baltimore-washington-superconducting-maglev-project. In August 2021, the FRA email to coordinating agencies stated: "I am writing to advise you that on August 25th the Federal Railroad Administration (FRA) paused the Environmental Impact Statement (EIS) for the Baltimore-Washington Superconducting Magnetic Levitation (SCMAGLEV) Project on the Permitting Dashboard to review project elements and determine next steps. FRA will follow up with Cooperating and Participating agencies when we have additional information to share. Regards, Marlys Osterhues, Chief, Environment and Project Engineering Division, Federal Railroad Administration."

of the proposed maglev before. Afterward, he said, "My only question is how soon can I ride it."

Audience members already familiar with the Baltimore-Washington maglev proposal found some of the statements odd that were made at the November 14 NASA seminar. Particularly baffling was the confidence that one of the seminar speakers expressed that the maglev would be built.

To put the maglev proposal in context, consider that a maglev is a kind of high-speed train, and since 2000, the Acela high-speed train has connected Washington and Baltimore with continuing service to Boston.[3]

By examining Acela's past ridership and expected future ridership, we can make an educated guess of how successful a Baltimore-Washington maglev could be. The short answer is that very few people use Acela to travel specifically between Baltimore and Washington. Instead, the great majority of the millions of trips made on Acela are longer trips. Meanwhile, the great majority of the millions of trips made between Baltimore and Washington are made by car, with the second-most-popular option being the slow but inexpensive commuter train.[4]

Before the Covid-19 pandemic, there were just 48 one-way Acela tickets sold per day on average, if you count passengers embarking at Washington Union Station and disembarking at Baltimore's Penn station and also those passengers making the trip in the reverse direction.

Without considering the possibility of a maglev being built, Amtrak forecasted that 80 one-way passenger-trips per day would be made in 2040 between these stations on the Acela high-speed train.[5]

If Acela and the proposed maglev were similarly attractive options, then the simplest approach to forecasting maglev ridership would be to split up the forecasted Acela riders between Acela and the maglev. Without having to be precise, such an estimate provides a sanity check on the maglev's official ridership forecast that was used in its 2021 draft environmental impact statement. The maglev is somewhat faster than Acela and is expected to have more departures per day than Acela, but maglev

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[3] Acela started revenue service in December 2000: https://history.amtrak.com/blogs/blog/happy-15th-anniversary-acela-express.

[4] Station-pair ridership for various modes of transportation observed in 2013 and forecast for 2040: FRA (2016), NEC Future EIS, vol. 2, Appendix B8, which republishes FRA (2015), NEC Future *Ridership Analysis Technical Memorandum*. Specific data from FRA (2015), Appendix I, Tables I-1 and I-4. Table I-4 is for the preferred alternative (Alternative 2) as stated in FRA (July 2017), NEC Future Record of Decision.

[5] For Acela in 2013, observed 17,595 one-way passenger-trips and forecast for 2040 of 29,170 one-way passenger-trips between Washington's Union Station and Baltimore: FRA (2015), Appendix I, Tables I-1 and I-4. Calculate the average per day by dividing per-year ridership by 365 days per year.

tickets would be more than three times as expensive as Acela tickets. Some of these factors are explored in Appendix A and Figure 1.[6]

However you split 80 one-way passenger-trips per day between Acela and the maglev, there are nowhere near enough riders to justify spending $17 billion to build a maglev line between Washington and Baltimore. The Acela line still makes sense, however, because so many people make long-distance trips on it between Washington and Boston. [7]

During the public-comment period that ended in May 2021, a number of people criticized the maglev's draft environmental impact statement for basing its calculations on a wild overestimate of the maglev's likely ridership. As explored in Appendix A of the present blog post, one line of reasoning finds that the maglev's official ridership forecast is a thousand times higher than can be justified.[8]

In 2021, people also pointed out that the maglev would increase greenhouse gas emissions and have a ticket price too high for most people to afford. On November 14, 2022, various critiques of the maglev resurfaced during the seminar at the NASA Goddard Space Flight Center, as described below.[9]

Confidence: Well-founded or Fanciful?

One of the two speakers at the November 14, 2022, NASA Engineering Colloquium was Tomoaki Seki, who was visiting from Japan. Mr. Seki works for the Central Japan Railway. This company has been developing superconducting maglev technology for the past thirty years.

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[6] In December 2022, a one-way Acela ticket for travel between DC and Baltimore costs $18–$23: https://www.amtrak.com/. The average maglev ticket is expected to be $60 in 2018 dollars: FRA (2021), Baltimore-Washington maglev draft EIS, Appendix D4, Table D4-27, pg. D-43. After correcting for the inflation that occurred between January 2018 and November 2022, $60 in 2018 dollars becomes $72 in 2022 dollars: https://www.bls.gov/data/inflation_calculator.htm. The price ratio is 3.6 (i.e., $72 / $20).

[7] $17 billion cost: FRA (2021), Appendix D4, Table D4-8, pg. D-21. The relevance of the Acela-vs.-maglev comparison: Lysy (2021), *An Economic Sense* blog.

[8] The maglev's official ridership forecast is too high: Kelley (2021) and Lysy (2021). High-speed rail has difficulty reducing road congestion: Congressional Research Service (2009); FRA (1997), pg. 7-4; FRA (2008), pg. 6-7. 150-mile trip length: FRA (2005), pg. ES-3. For a partial list of documents pointing out weaknesses in the maglev proposal see the "SCMagLev Opposition" page of the Maryland Coalition for Responsible Transit website, http://mcrt-action.org/.

[9] A maglev is bad for the environment because it uses so much energy: Hidekazu and Nobuo (2017); and Randal O'Toole *At Liberty* blog (2013). Maglev operations would increase CO_2 emissions: FRA (2021), Appendix D4; and Kelley (2021), Chapter 4. In contrast, the plans to improve Amtrak service between Washington DC and Boston would result in a net decrease in greenhouse gas emissions: FRA (2016), vol. 1, pg. 4-38, Table 4-2. The 2021 maglev draft EIS's comment period ended in May 2021: https://www.marylandmatters.org/2021/03/23/state-feds-extend-public-comment-period-on-maglev/.

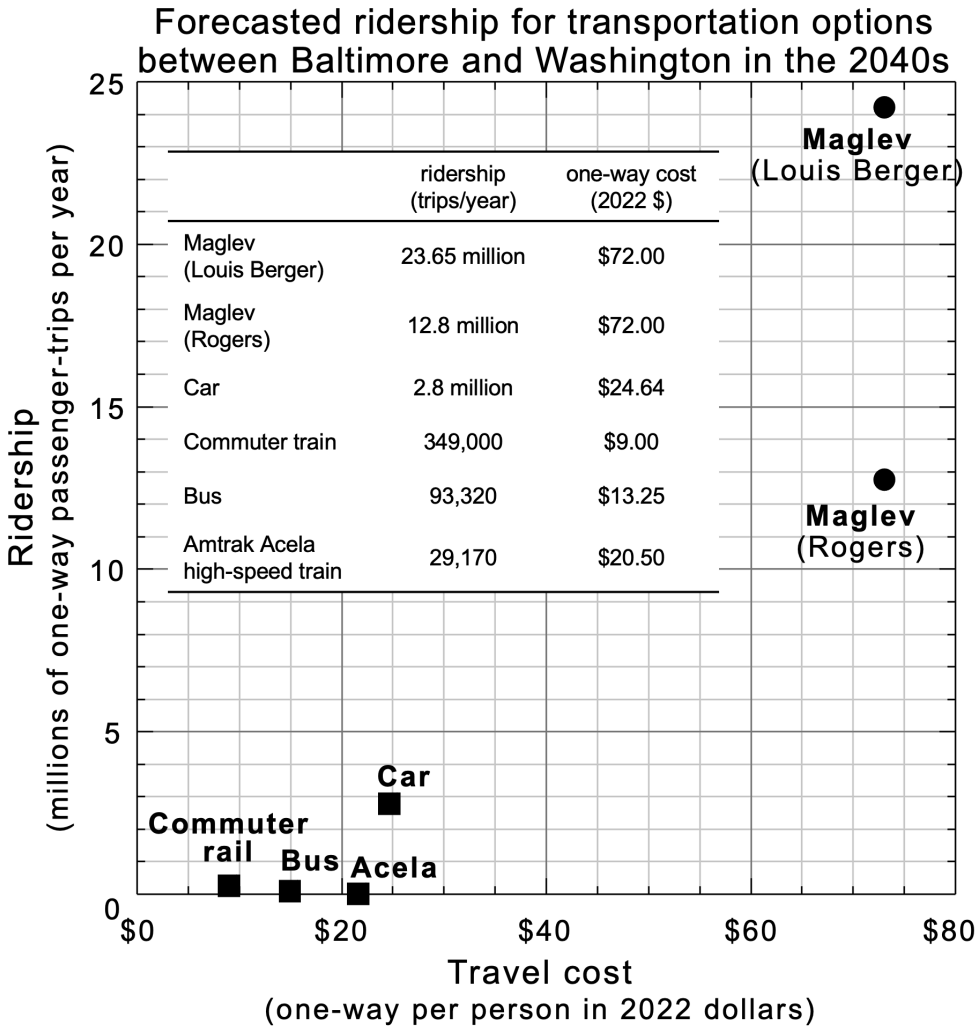

Figure 1. The forecasted maglev ridership and passenger cost are outliers compared with forecasts for the Amtrak Acela high-speed train and other forms of transportation between Baltimore and Washington, DC. For the data sources, see Appendix A of the present blog post.

Mr. Seki described maglev technology, including some of its strengths and weaknesses. The seminar's other speaker, Ian Rainey, painted a rosy picture of the maglev's benefits to society and tried to deflect audience criticism of the proposal.

When answering a question from the audience, Mr. Seki admitted that superconducting maglev technology had yet to be a commercial success despite the Japanese government funding research in this field since 1962. No rail line has ever operated commercially in Japan or anywhere else using superconducting maglev technology. The closest thing to a commercial superconducting-maglev line is the engineering test track in Japan. The test track

has a single station and gives rides to tourists between tests.[10]

Mr. Seki described how the superconducting part of the train engine is extremely complex because it needs to use both liquid helium and liquid nitrogen to cool the magnets to within a few degrees of absolute zero. For this reason, the Central Japan Railway has developed an alternative magnet that becomes superconducting at a somewhat higher temperature. Mr. Seki mentioned that the Central Japan Railway has yet to establish the long-term reliability of the higher-temperature magnets, so they are still being tested on the maglev test track.[11]

The other speaker at the November 14 Engineering Colloquium was Ian Rainey, a representative of Baltimore Washington Rapid Rail (BWRR), the company that wants to build a maglev line between Baltimore and Washington. Mr. Rainey expressed optimism that the maglev would be built.

In his statements, Mr. Rainey carefully avoided claiming that the United States government had committed to restarting the maglev's environmental review after halting it in August 2021. Mr. Rainey stated his "hope" that the environmental review would restart "in 2024," but he added that the decision was "up to the federal government."

Outside of the auditorium on November 14, Mr. Rainey told several audience members that, assuming a favorable environmental review and sufficient funding, there would be a design period and then a construction period of 7 to 10 years. In short, Mr. Rainey appeared confident that, in approximately 2035, BWRR would begin operating the maglev.

It is possible that Mr. Rainey has good reasons to be optimistic. Perhaps, BWRR has information that has not been shared with the public. Alternatively, Mr. Rainey may have been glossing over the maglev's diminishing prospects.

Without a clear government pronouncement that the maglev project is terminated, it is prudent to examine Mr. Rainey's statements for clues that the project is still a going concern and that the maglev would provide real benefit to the region. The rest of the present blog post attempts to do so.

Greenhouse Gas Emissions

During the November 14 Engineering Colloquium, Mr. Rainey said that the maglev would "take 10 million cars off the road." At first glance, this number sounds impressive, but actually it's nonsense because there are only 5 million cars registered in Maryland.

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[10] The test track may be called the "Yamanashi Maglev Test Line" or "Yamanashi Prefectural Maglev Exhibition Center and Test Track:" https://web-japan.org/atlas/technology/tec04.html.

[11] The niobium-titanium alloy becomes superconducting at 4.2 Kelvin which equals -269° Celsius and -452° Fahrenheit: Ueno (2014). Absolute zero is 0 K and -273.15° C.

Even maglev proponents don't expect the maglev to empty the roads.[12]

If Mr. Rainey had used the correct units of "car-trips" rather than "cars," then his figure would have sounded less impressive and yet it may still be a gross overestimate of the maglev's impact as previously discussed in the Background section. Mr. Rainey's use of the wrong scientific unit was not necessarily an accident. The CEO of BWRR made the same error recently in testimony before Congress. The CEO said that the proposed maglev would take 16 million cars off the road.[13]

The maglev's ability to reduce road congestion has been hotly debated in recent years, and this issue is important because it affects the maglev's climate impact.

In response to an audience comment during the November 14 Engineering Colloquium, Rainey claimed the maglev would "tremendously" reduce greenhouse gas emissions because the maglev would take so many cars off the road.[14]

Mr. Rainey's grand claim about the maglev's climate impact is flatly contradicted by data in the maglev's 2021 draft environmental impact statement (EIS). These data establish that the net effect of operating the Baltimore-Washington maglev would be to increase CO_2 emissions by 286 to 336 million kilograms annually. According to the draft EIS's data, generating the electricity to run the maglev would increase CO_2 emissions by so much that it would more than cancel out the modest reduction in CO_2 emissions from car drivers switching to riding the maglev. The federal government and State of Maryland are looking for ways to reduce greenhouse gas emissions, and the maglev would be a big step backward.[15]

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[12] 5 .1 million Maryland register cars in Maryland in 2022: CSV formatted file for MVA vehicle registration by county from 2010 to 2022, https://opendata.maryland.gov/Transportation/MVA-VEHICLE-REGISTRATION-by-COUNTY-from-2010-to-20/kqkd-4fx8.

[13] BWRR CEO Wayne Rogers is alleged to have said the maglev would "remove 16 million cars from the corridor's roads," *Baltimore Sun* (July 1, 2021). Mr. Rogers also testified before Congress that the maglev would eliminate "16 million cars and 2 million tons of greenhouse gas," May 6, 2021, U.S. House of Representatives, Subcommittee on Railroads, Pipelines, and Hazardous Materials, https://www.congress.gov/event/117th-congress/house-event/LC67538/text?s=1&r=93.

[14] An audience member asked about how much energy the maglev consumed, and Mr. Rainey responded, somewhat off topic, that the maglev would "take 10 million cars off the road" and "tremendously" reduce greenhouse gas emissions.

[15] The maglev's 2021 draft EIS's estimate of net climate impact comes from adding the increased emissions from electricity generation to run the maglev and the reduction in emissions from car travel being diverted to the maglev. The official forecast of the maglev-related reduction in car travel would result in a reduction of 124 to 174 million kilograms per year of CO_2 emissions: FRA (2021), Appendix D4, Table D4-40. The 460-million-kilogram increase in CO_2 emissions to generate electricity to run the maglev: FRA (2021), Appendix D4, Table D4-43. See also Chapter 4 of Kelley (2021).

The maglev's climate impact would be even worse if the maglev's ridership were lower than the official forecast that the Louis Berger consulting company generated in 2020. A lower ridership for the maglev would mean fewer car drivers would switch to riding the maglev. The maglev's climate footprint cannot be reduced by running fewer maglev trains because the resulting longer lag between departures would likely reduce maglev ridership even more.

In addition, building the maglev's track and other facilities would emit a large amount of CO_2. Construction emission would be 249 to 721 million kilograms of CO_2 or much more depending on the estimation method used.[16]

Independent Utility

During the November 14 Engineering Colloquium, an audience member asked if it were wise to study the pros and cons of a maglev line that would run between only Washington and Baltimore because Baltimore Washington Rapid Rail (BWRR) clearly wants to build the line from Washington to New York City. No environmental impact study has been initiated for the Washington-to-New-York-City route, and the federal government paused the review of the Washington-to-Baltimore segment in August 2021.[17]

The National Environmental Protection Act (NEPA) does allow a regulatory agency to forecast the environmental impact of one part of a larger project, but only if that part has "independent utility." This phrase applies to a transportation project that would "be usable and be a reasonable expenditure even if no additional transportation improvements in the area are made." [18]

Mr. Rainey claimed on November 14 that an unspecified programmatic environmental impact statement (EIS) provided the justification for studying a maglev between just Baltimore and Washington. To define the

[16] Increased CO_2 emissions to construct the maglev could be as high as 10 billion kilograms: Kelley (2021), Chapter 4, Appendix 2, pp. 78–80. The beneficial effects of reduced car travel estimated in the 2021 draft EIS assumes that most of the people who choose to ride the maglev would otherwise use gas-powered cars, not electric cars. An electric car emits less greenhouse gas than a gas-powered car. BWRR has a history of making false statements about the climate impact of the maglev. On January 31, 2017, at a hearing seeking a favorable resolution from the Baltimore City Council, BWRR CEO Wayne Rogers is alleged to have said "the project is electric, meaning no emissions:" Baltimore City Council, 2017, page 3 in hearing notes and page 15 of the complete bill. The truth is that all methods of generating electricity release greenhouse gasses to construct a generating facility, and in most cases, to operate the generating facility.

[17] Audience member Susan McCutchen asked the question. Mr. Rainey's Nov. 14, 2022, presentation promotes the DC-NYC route as does BWRR's website.

[18] Quote from the Code of Federal Regulations 23 CFR 711.111(f)(2), which is part of the regulations that implement NEPA for transportation projects, https://www.ecfr.gov/current/title-23.

term, a programmatic EIS studies a large project, and it is sometimes called a tier-1 EIS. After a programmatic EIS is published, several documents are published that each focus on part of the overall project. Each of these more focused documents is called a tier-2 EIS.

Mr. Rainey does not name the programmatic EIS to which he is referring. A reasonable guess would be that he is referring to the only programmatic EIS ever written about maglevs. That document was published 22 years ago in 2001. This guess is only speculation because the 2021 draft EIS for the currently proposed Baltimore-Washington maglev does not explicitly claim to be a tier-2 EIS under any programmatic EIS.[19]

Furthermore, it seems a bit much for Mr. Rainey to expect us to believe that a document published in 2001 could accurately forecast the ridership, financial viability, and independent utility of the currently proposed superconducting Baltimore-Washington maglev in 2045. Using a document this old in this way would be like using a document written during the early days of the personal computer (the mid-1980s) to predict a social-media company's prospects in 2030. Technology and society change considerably and in unexpected ways in about half a century.[20]

Worse yet for Mr. Rainey, this 22-year-old document, the 2001 programmatic EIS, did not state that a maglev between Baltimore and Washington would have independent utility. Instead, this old document merely stated that the Baltimore-Washington route was worth further study.[21]

If one looks elsewhere for evidence that a maglev between Baltimore and Washington would have independent utility, one comes up empty handed. It appears that no one has

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[19] When announcing on November 25, 2016, the plan to write the Baltimore-Washington superconducting maglev EIS, the *Federal Register* (vol. 81, pg. 85320) did not claim this new EIS to be a tier-2 EIS under the much earlier 2001 Maglev Deployment Program (MDP) programmatic EIS. This *Federal Register* announcement mentions the MDP only in connection with the 2003 Transrapid draft EIS. The maglev's 2021 draft EIS itself mentions two programmatic EISs but does not claim to be a tier-2 draft EIS under either program: Maglev Deployment Program (Section 1.2.1), and Amtrak's NEC Future (Section 1.2.2).

[20] https://en.wikipedia.org/wiki/IBM_Personal_Computer

[21] The 2001 programmatic EIS (FRA 2001) describes the Baltimore-Washington route on pages 2-27 to 2-30 as the "initial link of a Northeast Corridor (NEC) system that could extend to the Southeast." FRA (2001) states that the earlier non-superconducting Baltimore-Washington project had "strong service characteristics, a strong financial planning, and appeared well on their way to putting together an effective public/private partnership" (page 2-36). However, the FRA (2001) fell short of asserting that Baltimore-Washington segment would have independent utility in the absence of the planned extensions north of Baltimore and south of Washington, DC. FRA (2001) does not even contain the phrase "independent utility." FRA (2001) states that further study is warranted for Baltimore-Washington route (page 2-36).

gotten around to publishing such a document.

In 2017, The Federal Railroad Administration (FRA) stated that BWRR still needed to establish that a maglev between Baltimore and Washington would have independent utility. This FRA statement is found in a 2018 scoping report that is cited in the 2021 draft EIS for the Baltimore-Washington maglev. One can speculate that the FRA may have left it to BWRR to establish independent utility because the FRA itself felt that a 36-mile-long maglev between Baltimore and Washington would actually lack independent utility. In a 2005 document, the FRA did determine that any maglev line under 150 miles long would lack utility as a means for reducing road congestion.[22]

Between 2017 and now, it appears that neither BWRR nor the FRA ever got around to laying out evidence that a Baltimore-Washington maglev would have independent utility. The project's 2018 scoping report contained literally one sentence on this topic, and that sentence sounds aspirational rather than declarative. Specifically, the maglev would "build upon previous efforts to provide a service between Baltimore and Washington that has independent utility." Three years later, the maglev's 2021 draft EIS made no mention of this topic.

Property Condemnation

During the November 14 Engineering Colloquium, Mr. Rainey said that Baltimore Washington Rapid Rail (BWRR) would build the maglev without condemning "a single private residence" in response to an audience question about how the maglev would impact communities along the track.

Mr. Rainey's exact statement cannot be proven false at this time, but his statement does dance around an inconvenient fact. During the past decade, BWRR has proven itself to be pro-condemnation to an extreme degree.[23]

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[22] FRA states that BWRR is responsible for establishing independent utility: notes from an Oct. 3, 2017, meeting that are included in FRA (2018), which is the *Preliminary Alternatives Screening Report*, which is itself included as Appendix E3 of FRA (2021). Specific quote from meeting notes: "FRA wants BWRR to show independent utility and ridership projections for the segment between Baltimore, MD to Washington, DC," FRA (2018), pg. C-22. 150-mile trip-length threshold: FRA (2005), pg. ES-3. Other documents casting doubt of utility of high-speed rail with short lines: Congressional Research Service (2009); FRA (1997), pg. 7-4; FRA (2008), pg. 6-7; and National Academies (1991), pp. 6–7. 33–36-mile track length for Baltimore-Washington maglev: FRA (2021), chap. 2, pg. 3-18, 3-19.

[23] On November 14, 2022, audience member Shavesha Rutledge asked about impacts to communities along the maglev track. Mr. Rainey responded that impacts would be minimal because 75% of the track would be underground and the maglev would avoid taking a single private residence. In the planning profession, "a taking" is synonymous with condemning a property through the government's power of eminent domain. When such a taking occurs, a landowner is forced to sell their property at fair market value. Various levels of government have a right to take property in this way so that the property can

During 2014–2015, BWRR used an unconventional shortcut to obtain a powerful form of condemnation authority. BWRR did not wait for federal regulators to recommend maglev construction, for various authorities to approve maglev construction, or for Congress to pass a bill authorizing any needed property condemnation.

Instead, BWRR asked the Maryland Public Service Commission in 2014 to grant BWRR the right to condemn properties that BWRR found "convenient or necessary" for building a maglev. The Public Service Commission is actually a Maryland court, and it deals with certain transportation-related cases in Maryland.[24]

BWRR's specific argument revolved around the fact that, long ago in 1912, the Maryland legislature granted a company a railroad franchise to build a railroad between Baltimore and Washington and to condemn land along that route. In 1935, that company ceased to exist without having built the railroad. In 2014, BWRR requested that the Public Service Commission transfer to BWRR the railroad franchise created by that 1912 legislative act.[25]

The staff of the Public Service Commission questioned the legality of BWRR's request. First, the staff suggested that the transfer could not occur now because the Public Service Commission is permitted to transfer a railroad franchise only at the time that the initial company abandoned that franchise. In this case, the abandonment occurred decades ago.[26]

Second, the staff suggested that the transfer could only be made if BWRR were

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subsequently be used for the public good. In many circumstances, the landowner can challenge the taking in court. The legislative body within a local government or the federal government can pass a bill that delegates to a private company a limited degree of condemnation authority. See Scheiderich et al. (2011).

[24] BWRR's request became Case #9363: Public Service Commission (2015). Eminent domain authority is likely the reason BWRR requested the transfer: pg. 6 staff response on December 22, 2014, https://www.psc.state.md.us/search-results/?q=9363&x.x=20&x.y=20&search=all&search=case. The Maryland Court of Special Appeals pointed out that Maryland law states, "A Maryland railroad company may acquire land and other property that it determines is ***convenient or necessary*** for the site of the railroad or for additions to the railroad by... purchase... or condemnation:" [italics added] Maryland Public Utilities Code, Ann. Section 9-303(b) (2020), https://law.justia.com/codes/maryland/2020/public-utilities/division-i/title-9/subtitle-3/section-9-303/. Mention of this law by the Maryland Court of Special Appeals, March 4, 2022, opinion 983-2021, https://casetext.com/case/balt-wash-rapid-rail-llc-v-westport-capital-dev.

[25] The 1912 legislation granted a franchise to build a railroad to the long-since-bankrupt Washington, Baltimore and Annapolis Electric Railroad Company. 1935 bankruptcy: pg. 2 of staff response, Case #9363, December 22, 2014.

[26] Staff reservations enumerated on pg. 3-4 of staff response, Case #9363, Dec. 22, 2014. "Staff is uncertain at best that the Commission has the authority to do as the Applicant requests. Staff believes it would be far better for the Applicant to seek and obtain its franchise directly from the Maryland General Assembly," pg. 4 of staff response, Case #9363, Dec. 22, 2014.

planning to provide an equivalent service to what the Maryland General Assembly authorized in 1912. In 1912, the plan was for an ordinary steel-wheel train, not a 300-mph superconducting maglev that uses different technology and has different risks.[27]

Despite its staff's initial misgivings, the Public Service Commission did give BWRR condemnation authority in November 2015, subject to a few conditions.[28]

Another way in which BWRR's pro-condemnation stance is extreme is that BWRR has been fighting in court to condemn 43 acres in Baltimore since June 2021. BWRR's timing and its justification for the condemnation are questionable. Federal regulators have yet to approve maglev construction and the required $17 billion to construct the maglev has yet to be arranged.[29]

BWRR claimed that it needed to condemn 43 acres of land along the Baltimore waterfront, land on which the current owner was about to start constructing 1,500 residential units. In court, BWRR claimed that it needed specifically these 43 acres in order to build a maglev maintenance facility and maglev-related parking garage.[30]

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[27] 2003 termination of maglev: Maryland House of Delegates bill HB935 in 2003, lines 15–23, page 42, House Bill 935 of the 2003 regular session, "Budget Reconciliation and Financing Act of 2003." The 2003 bill's impact is discussed in the analysis of 2020 bill HB733, https://mgaleg.maryland.gov/2020RS/fnotes/bil_0003/hb0733.pdf.

[28] One limitation was that the Baltimore City Council approve of the transfer of the railroad franchise. This limitation is referred to as "staff condition #2" in Case #9363. See pages 11–12 of the brief of the staff of the public service commission, Case #9363, August 17, 2015. See also page 24 of the proposed order of public utility law judge, Case #9363, October 14, 2015. On Jan. 31, 2017, the Baltimore City Council was in favor of the maglev, and it passed a resolution to this effect (bill #17-0004). Subsequently, the Baltimore City Council became opposed to the maglev and submitted comments in May 2021 opposing the maglev (*Baltimore Sun* June 23, 2021; July 1, 2021). One might wonder if BWRR would lose its authority to condemn land if the Baltimore City Council were to repeal resolution #17-0004.

[29] The development would be called One Westport: https://www.onewestport-baltimore.com/. The 43-acre waterfront site: *Washington Business Journal*, July 2, 2021. BWRR files to condemn on June 8, 2021: Court of Special Appeals (2022). The 43 acres are bounded by water to the east, Kloman Street to the west, Waterview Ave. to the south, and its northern edge is about 300 feet south of Interstate 95: Baltimore CodeMap online GIS, reachable from the "GIS and Mapping" page of the Baltimore Department of Planning, https://planning.baltimorecity.gov/maps-data/gis/. $17-billion construction cost: FRA (2021), Appendix D4, Table D4-8, pg. D-21.

[30] BWRR made its statement about its need for the 43 acres in circuit court. BWRR's statement is paraphrased in the Court of Special Appeals opinion (2022): "BWRR explains that it needs the Property to construct and operate its railroad and that the Property is necessary regardless of which of two proposed alignments for the SCMAGLEV is selected. BWRR posits that the Property is necessary for the Baltimore City SCMAGLEV Station, a maintenance area and maintenance tail track, a parking area, and construction areas." On March 4, 2022, the Maryland Court of Special Appeals tells the Circuit Court for Baltimore City to reconsider its rejection of BWRR's request to condemn the 43 acres: https://casetext.com/case/balt-wash-rapid-rail-llc-v-westport-capital-dev. The Circuit Court had

Figure 2. Forty-three contested acres in Baltimore, Maryland. In 2021, the CEO of Baltimore Washington Rapid Rail claimed in court that his company needed to take possession of these 43-acres of Baltimore waterfront property in order to build the maglev. The property is outlined in blue in this figure. The project's draft environmental impact statement (EIS), however, showed no maglev-related construction planned for these 43 acres (chapter 4.9, Figure 4.9-10, page 4.9-16). This zoomed-in version of the figure from the EIS has additional text labels added in red and blue.

The maglev's 2021 draft environmental impact statement (EIS), however, contradicts BWRR's claim. The diagrams and 3D renderings in the draft EIS show these 43 acres completely vacant, i.e., as a grassy field. The maglev parking and rail maintenance facilities would be located elsewhere. For example, see Figure 2.[31]

On November 14, 2022, Mr. Rainey's claim at the NASA's Engineering Colloquium that BWRR will not condemn a single residential property seems disingenuous considering his

dismissed BWRR's condemnation filing on August 30, 2021. This dismissal occurred a few days after the Federal Railroad Administration halted the maglev's environmental review. 1,500 homes planned: H. Wilen, *Baltimore Business Journal*, June 29, 2021.

[31] No plan to build maglev-related infrastructure on these 43 acres: FRA (2021), chap. 4.9, Fig. 4.9-10, pg. 4.9-16, and Appendix C, Fig. C11, pg. C-18. The text that accompanies Fig. 4.9-10 states that, under the maglev's Cherry-Hill-station alternative, the maglev parking and ancillary facilities would be south of Waterview Ave. and between Waterview Ave and I-295. Page 4.9-17 makes no mention of maglev-related construction on these 43 acres.

firm's aggressive efforts to acquire and use condemnation authority. The preceding paragraphs have established this fact.

Perhaps, Mr. Rainey felt compelled to make such a tortured statement because his company fears the Maryland General Assembly's views on the maglev and property condemnation. Each year starting in 2018, one or more bills to cancel or severely hamper the maglev have been introduced in the Maryland General Assembly. These bills are listed in Appendix B of the present blog post. A number of these bills drew attention to BWRR's condemnation authority. None of them have passed.

BWRR should fear the Maryland General Assembly because, the only other time that a maglev was proposed between Baltimore and Washington, it was the Maryland General Assembly that terminated the project. In 2003, the General Assembly terminated an earlier maglev proposal by cutting off funding for studying its environmental impact and designing it.[32]

Conclusion

The proposed maglev rail line between Baltimore and Washington DC is unlikely to be built, based on publicly available information. Nonetheless, the company that wishes to build the maglev, Baltimore Washington Rapid Rail (BWRR), still expresses confidence that the maglev will be built.

During a seminar on November 14, 2022, held at NASA Goddard, a BWRR representative named Ian Rainey expressed optimism about the maglev's prospects. He painted a rosy picture of the benefits that the maglev would provide. An analysis of Mr. Rainey's statements on November 14 shows that some of them omit relevant information and others contradict official documents.

What is known for sure is that, back in August 2021, the Federal Railroad Administration (FRA) halted the Baltimore-Washington maglev's environmental review. Since then, the FRA has not set a date for restarting the review. Meanwhile, independent analyses find that the maglev would attract far fewer riders than is predicted in the official ridership forecast. There is reason to question the advertised benefits of the maglev and its financially viability.

The proposal to build a maglev line between Baltimore and Washington appears to be dead in the water, but the company that wants to build it may have information that has not been shared with the public.

[32] In 2003, Maryland House of Delegates bill HB935 stated, "the state may not enter into an agreement for construction or operation of a rail system based on magnetic levitation technology except pursuant to an act of the General Assembly specifically authorizing the project" (pg. 43 of 89). See also Appendix B of the present blog post.

Individuals who are concerned about the maglev should continue to monitor the situation and spread the word if anything develops.

Disclaimer

This analysis was performed by an area resident, acting in his capacity as an individual citizen to examine a non-partisan issue of interest to the public. If errors are suspected, please contact the author at okelley@gmu.edu. Prior phases of this analysis have been published in the Greenbelt Online blog, www.greenbeltonline.org/blog.

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APPENDIX A: Ridership

The Louis Berger consulting company developed a ridership forecast for the proposed Baltimore-Washington maglev that it published in 2018 with an update in 2020. The range in the 2020 report was 22.4 to 24.9 million one-way passenger-trips in the year 2045. Subsequently, the Federal Railroad Administration (FRA) acted as if the 2020 Louis Berger forecast were reasonable by allowing that forecast to be the basis for calculating the maglev's benefits that were stated in the maglev's draft environmental impact statement (EIS).[33]

The Louis Berger Group who authored the maglev's official ridership report has issues, although there is no evidence that the company's alleged wrongdoing affected its work on the maglev ridership forecast. The company admitted to criminal responsibility in its contracts in Afghanistan. It was temporarily debarred by the World Bank for corruption. In 2019, the US National Transportation Safety Board found that the company had provided an inadequate design review of a bridge, a bridge that later collapsed causing 6 fatalities.[34]

This appendix presents three ways to quantitatively critique the Louis Berger 2020 maglev ridership report. Two of these approaches are supported by documents published by the Federal Railroad Administration (FRA), and one uses data from other sources.

In 2021, Frank Lysy used the NEC Future ridership forecast to come to the conclusion that Louis Berger's maglev ridership forecast was about 1,000 times higher than reasonable. In 2021, Owen Kelley independently came to a similar conclusion after examining transportation and income data. Kelley found a factor of 100 error in the Louis Berger forecast for diverted travelers, travelers that would make the trip by other means if the maglev were not built.[35]

For details of these two approaches, see the sections below titled "×1000 error" and "×100 error." The third way to quantitatively critique the 2020 Louis Berger maglev ridership report is to use a document that the FRA published in 2005. The 2005 document states a threshold that a maglev line that is under 150 miles long cannot compete with the convenience of traveling by car. Therefore, a maglev line shorter than 150 miles has little chance of significantly reducing road

[33] 22.367–24.939 million one-way passenger-trips in 2045: Louis Berger (2020), Table 8. Also found in FRA (2021), Chapter 4.2, Table 4.2-3, pg. 4.2-7. The two-year-earlier Louis Berger report had somewhat different numbers: Louis Berger (2018), Section 7.2.

[34] https://en.wikipedia.org/wiki/Louis_Berger_Group

[35] Lysy (2021), *An Economic Sense* blog, post on May 23, 2021, https://aneconomicsense.org/. Kelley (2021), *Ridership Revisited,* and related posts on the *Greenbelt Online* blog, https://www.greenbeltonline.org/.

congestion. The track of the proposed Baltimore-Washington maglev would be only 36 miles long.[36]

Definitions

Ridership Units

It is important to be clear what the term "ridership" means. In transportation planning, ridership is not the number of unique riders who make one or more trips during a period of time. In other words, ridership is a count of unique individuals.

Instead, ridership is usually expressed as the number of one-way customer trips made on a rail line over a period of time, such one year or one day. The ridership number would be the same whether a few people made many trips or many people made few trips. This unit of ridership is referred to as a passenger-trip and is usually reported by counting one-way trips, not round trips. A one-way passenger-trip is distinct from a one-way train trip or a passenger mile. The later is the product of the number of miles a train moves and the number of passengers on the train at that time.[37]

Travel Cost

The average one-way ticket price for the Baltimore-Washington maglev is $60 in 2018 dollars according to FRA (2021), which is the maglev's draft environmental impact statement (EIS). The rush-hour price ("peak" price) would be $70–$79 in 2018 dollars. Correcting for inflation, these prices in 2022 dollars would be $72 and $90 for the average and rush-hour ticket price, respectively.[38]

On the Amtrak website in December 2022, tickets for the Acela high-speed train were only $18–$23 one-way between Baltimore and Washington. At these prices, riding the maglev instead of Acela would cost an extra $52 ($72 for the maglev vs. $18–$23 for Acela).[39]

Driving would cost about the same as riding Acela if you include both wear-and-tear on the car as well as gas money. In some

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[36] FRA (2005), *Report to Congress: Costs and Benefits of Magnetic Levitation*. Other documents casting doubt on the utility of high-speed rail with short lines: Congressional Research Service (2009); FRA (1997), pg. 7-4; FRA (2008), pg. 6-7; and National Academies (1991), pp. 6–7. 33–36-mile length: FRA (2021), chap. 2, pg. 3-18, 3-19. 33–36-mile length: FRA (2021), chap. 2, pg. 3-18, 3-19.

[37] Ridership defined as the "number of rides taken by people using a public transportation system in a given time period:" FRA (2021), Appendix A, pg. A1-10. Another definition of ridership in FRA (2016), chap. 5: "Passenger rail travel data are presented as passenger trips (trips)—also called boardings—which measures the number of times a passenger boards a passenger rail vehicle. Ridership is a compilation of unlinked, one-way trips."

[38] $60 average price: FRA (2021), Appendix D4, Table D4-27, pg. D-43. $70–79 rush-hour price: FRA (2021), Appendix D2, Table D2-35, pg. D-180. Inflation correction using CPI ratio of x1.20 between January 2018 and November 2022: https://www.bls.gov/data/inflation_calculator.htm.

[39] Amtrak fare: https://amtrak.com.

circumstances, the IRS allows a tax deduction of 56 cents per mile for travel by car, which works out to $24.64 to make the 44-mile trip by car between Baltimore and Washington.

Willingness to Pay

The paragraphs above estimated that it would cost an extra $52 to ride the maglev instead of taking the existing Acela high-speed train. The incentive for switching from Acela to the maglev would be that the maglev would make the trip about 12.5 minutes shorter than Acela would.

The maglev-vs.-Acela time difference of 12.5 minutes is based on the following considerations. The maglev is advertised as a 15-minute ride while Acela is expected to be about a 27.5-minute ride in the 2040s. Currently, Acela takes 29–32 minutes to travel from Washington Union Station to Baltimore Penn Station. Various improvements to Acela between now and the 2040s are expected to reduce the Acela trip duration by 5 minutes.[40]

The maglev would offer about the same travel-time savings to car drivers as it would to Acela passengers. The 2021 maglev draft EIS estimates the maglev would save its customers 8–27 minutes vs. other forms of transportation.[41]

Back to Acela vs. maglev. If the maglev saved customers 12.5 minutes compared to Acela but the maglev cost $52 more than Acela, that would mean that a maglev customer would have to be willing to pay for travel-time savings at an hourly rate of $250/hour. This is a lot to ask.

Being willing to pay $250/hour for travel-time savings is far outside what is typically considered valid in transportation planning. For example, the NEC Future ridership report suggests that a non-business traveler is willing to pay $6/hour to save travel time, a commuter $28/hour, and a business traveler $41–$92/hour.[42]

Even if one exceeds the normally allowed range of willingness-to-pay, the ridership

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[40] The Baltimore-Washington maglev is advertised as a 15-minute ride, but FRA thinks that the ride might take a bit longer. Specifically, FRA (2018), *Final Preliminary Alternatives Screening Report*, pg. C-22, includes the statement that the FRA "is pushing back on [the] 311 mph and 15 minutes travel time language in the [maglev] Purpose and Need Document... to avoid litigation" in minute of an Oct. 3, 2017, meeting. Acela ride currently 29–32 minutes: schedule on Amtrak's website. Acela DC-to-Baltimore will be 2.5 minutes shorter once a tunnel is replaced: FRA (2017), *Record of Decision: Baltimore & Potomac Tunnel*. For the tunnel project, Alternative 3B is the preferred alternative (pg. 13) and it would save 2.5 minutes (pg. 15). Acela DC-to-Baltimore trip will be a total of 5 minutes shorter after all planned improvements, which include increasing the number of tracks to 4: FRA (2016), vol. 1, chap. 4, Table 4-6, pg. 4-50.

[41] 8–27 minutes: FRA (2021), Appendix D4, pg. C-6.

[42] Willingness to pay: FRA (2016), vol. 1, Appendix BB, Table 11, pg. BB-33. Non-business value of time of $6/hour for tickets under $50, otherwise $6–$18: FRA (2015), pg. 46.

potential for the maglev is dismal. About 2% of DC workers and 1% of Baltimore workers make at least $250/hour according to US Census Bureau data from 2019. That hourly earning rate is achieved only by someone making $500,000 a year, assuming a 2,000-hour work-year. This rough calculation assumes that a traveler is willing to spend at a rate equal to his or her hourly-earnings rate in order to save travel time.[43]

Combining DC and Baltimore data, about 1.5% of workers earn enough to find the maglev travel-time savings attractive given the maglev ticket price. For simplicity, this calculation does not include two factors that roughly cancel out. There has been wage inflation between 2019 and 2022, which would serve to make the maglev seem more affordable. This factor is roughly canceled out by the fact that workers are typically willing to spend at a rate of less than 100% of their hourly earnings to achieve travel-time savings according to the 2018 Louis Berger ridership report.[44]

×1000 error

The maglev's official ridership forecast is found in the 2020 Louis Berger report and maglev's 2021 draft environmental impact statement (EIS). The official forecast appears too high by more than a factor of 1,000 based on the NEC Future ridership forecast. This 2015 document was reprinted as an appendix of the 2016 NEC Future environmental impact statement.

The relevance of the 2015 NEC Future ridership study was first explored by Frank Lysy in a 2021 post on his blog, *An Economic Sense*. Lysy also submitted his analysis to the Federal Railroad Administration in May 2021 during the maglev's public-comment period. The analysis presented here does not reproduce Lysy's exact numbers but does use Lysy's general approach.[45]

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[43] For simplicity, the calculation in this paragraph assumes that workers are willing to pay 100% of their hourly earnings to save travel time. The 2018 Louis Berger ridership report states that the US Department of Transportation guidelines are that only business travelers are willing to pay this much: Louis Berger (2018), Table 5-1, pg. 54. US Census data from 2019 reviewed in Kelley (2021), chap. 2, Table 2, pg. 37.

[44] Wage inflation between 2019 and 2022 of approximately 14%: https://www.frbsf.org/economic-research/publications/economic-letter/2022/september/wage-growth-when-inflation-is-high/. The 2018 Louis Berger report gives the US Department of Transportation percentages of salary for three types of passengers and the maglev's 2021 draft EIS gives the market share of these types of passengers. US DOT value-of-time guidelines as a percentage of hourly wage of 60%–90% for non-business travelers, 35%–60% for commuters, and 80%–120% for business travelers: Louis Berger (2018), Table 5-1. Maglev ridership market share of 44.6%, 25.4%, and 15.4% for non-business travelers, commuters, and business travelers: FRA (2021), Appendix D4, Table D4-19, pg. D-35. A weighted average of these quantities is 61%, calculated from 0.75×0.446 +0.475×0.254 +1.0×0.154.

[45] *An Economic Sense* blog, May 23, 2021, https://aneconomicsense.org/.

Since 2000, the Amtrak Acela high-speed train had provided a service somewhat similar to the proposed maglev, and the NEC Future program would make Acela even more similar to the maglev in terms of trip duration and frequency of trains.

The NEC Future forecast for Acela ridership in 2040 is 29,170 one-way passenger-trips per year between Baltimore and Washington. The NEC Future forecast assumes the maglev would not be built. This annual figure is equivalent to an average of just 80 one-way passenger-trips per day, including northbound and southbound trips.[46]

Figure 3 of the present blog post is a schematic diagram of Lysy's analysis method. Near the top of Figure 3 is shown the NEC Future forecast of 80 one-way passenger-trips per year on the Acela between Baltimore and Washington, assuming that the maglev were not built. These 80 trips are taken by the small pool of Baltimore-Washington travelers who would choose high-speed rail over driving their car or commuter rail.

The next step is to determine how to divide up this pool of high-speed rail passengers between Acela and the maglev, in the scenario where the maglev is built.

If the maglev were built and its service were similarly attractive to Acela, then transportation modelers would, to a first approximation, forecast that the existing high-speed train riders would be split equally between the two high-speed rail options. The Willingness to Pay section above establishes that Acela is preferable to the maglev from a price-vs.-time-savings point of view, but to be generous to the maglev, the rest of this section assumes a 50-50 split between Acela and the maglev.[47]

An equal split would mean about 40 one-way passenger-trips per day on Acela and 40 one-way passenger-trips on the maglev. This equal split is indicated by the "×0.50" number in Figure 3. That number is equivalent to 14,610 passenger-trips per year.

In contrast to this low number, Louis Berger forecast in 2020 that the maglev in 2045 would have about 23.65 million one-way passenger-trips per year. This maglev forecast is inexplicably higher by a factor of about 1,600 compared to the rough estimate based on Lysy's method of analyzing the NEC Future forecasts (23.65 million / 14,610). This ratio is shown at the bottom of Figure 3.

That the 2020 Louis Berger forecast is bizarrely high can also be seen from the fact

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[46] FRA (2016), Amtrak NEC Future programmatic EIS, vol. 2, Appendix B8, which is a republishing of FRA (2015), *Ridership Analysis Technical Memorandum*. Specific data from Appendix I, Table I-4.

[47] Split riders equally when two equally attractive mode choices are available for making a trip. This concept is built into the logit equation that is commonly used in transportation modeling: Willumsen (2014, pg. 108).

that the Louis Berger forecast for the maglev is seven times higher than the total number of trips between Baltimore and Washington that the NEC Future forecast shows for all modes of transportation in the year 2040.[48]

Lowering the maglev ticket price wouldn't help the maglev that much. If the 2015 NEC Future ridership study does establish the market for high-speed rail between Baltimore and Washington, then one implication is that the maglev could not increase its ridership that much even if it drastically cut its ticket price. As currently planned, the maglev tickets would cost $72 one-way in 2022 dollars, which is about 3.6 times more expensive than the other high-speed rail option, namely Amtrak Acela with $20 tickets in 2022.

Suppose the maglev cut its ticket price from $72 to $20 one-way. With an equally priced ticket and a somewhat shorter total trip duration than Acela, the maglev might then capture most or all of the high-speed-rail market of 80 one-way passenger-trips per day between Baltimore and Washington in 2040. Eighty passenger-trips per day is the potential customer base for high-speed rail according to the NEC Future ridership study. But the problem with this discount-ticket scenario is that the maglev's ridership would still be a factor of 800 less than forecast in the 2020 Louis Berger maglev report. Worse yet, the maglev's revenue would fall even further below expectations in this scenario because the maglev tickets would be so steeply discounted (from $72 to $20). It is hard to see how any business could be financially viable with its revenue so far below expectations.

×100 error

The previous argument hinges on the reliability of the NEC Future ridership forecast published in 2015. It would be helpful to have a way to confirm this conclusion.

Such confirmation comes from a 2021 analysis by Owen Kelley, the author of the present blog post. This 2021 analysis is based on a travel survey conducted by the Metropolitan Washington Council of Governments (MWCOG) and income data from the US Census Bureau. This analysis method is described in the author's 2021 publication, *Ridership Revisited*, and is summarized in the following paragraphs. The analysis presented here does not reproduce the exact numbers from Kelley (2021), but it does use the same general method. Figure 4

[48] 3.279 million trips by all modes of transportation between Baltimore and Washington in 2040, consisting of 2.808 million by car, 0.093 by bus, 0.029 million by Acela, and 0.349 million by commuter rail: FRA (2015), Appendix I, Table I-4, ridership under NEC Future Alternative 2, the studied alternative that is closest to the preferred alternative. From 22.4 to 24.9 million maglev passenger-trips per year in 2045: Louis Berger (2020), Table 8; and FRA (2021), chap. 4.2, Table 4.2-3, pg. 4.2-7.

of the present blog post is a schematic representation of this analysis method.

Kelley's 2021 analysis method shows that the 2020 Louis Berger maglev-ridership forecast is too high by a factor of over 100 among diverted travelers. A diverted traveler is someone who would make the trip by other means if the maglev were not built. According to the maglev's 2021 draft EIS, diverted travelers would make up the large majority of the maglev's total ridership, 83% of it.[49]

The Metropolitan Washington Council of Governments' regional traffic survey for 2017-2018 is used here. According to that survey, there were 18,956 one-way trips per weekday in 2018 between jurisdictions where the proposed maglev stations would be no more than a short detour relative to driving straight from the trip origin to the final destination. This means origins and destinations in the following jurisdictions: the District of Columbia, Arlington, or Alexandria at one end of the trip and Baltimore City or Baltimore County at the other end.[50]

About 1.5% of Baltimore-Washington workers make enough money that paying an extra $52 to save about 12.5 minutes would seem worth it. That's the time savings and cost difference described in the Travel Cost and Willingness to Pay sections above.[51]

Next, convert from trips per day to trips per year. Expand the observed trips from the 2018 regional traffic survey to a value for 2045. The maglev's 2021 draft EIS suggests one factor to convert a 2018 figure to a value for 2045. That factor is 1.284, which assumes an increase in travel of 0.93% per year. The result of this calculation is 133,350 one-way maglev passenger-trips per year in 2045.

In contrast to the just derived 133,350-trip forecast, the maglev's 2021 draft EIS assumed that diverted travelers would make 18.7 to 20.6 million one-way passenger-trips on the Baltimore-Washington maglev in 2045. The middle of this range is 19.65 million passenger-trips per year. The draft EIS's estimate for diverted car commuters is a factor of about 147 higher than the number calculated in the previous paragraphs from the MWCOG's regional traffic survey (147 ≈

[49] 83% of maglev passenger-trips are made by diverted travelers, 18.658–20.579 million one-way passenger-trips per year out of a total ridership of 22.367–24.939 million one-way passenger-trips per year: FRA (2021), chap. 4.2, Table 4.2-3. Explicit statement that 15–17% of ridership is induced, which implies the remaining 83%–85% is diverted: FRA (2021), Appendix D4, pg. D-44.

[50] Metropolitan Washington Council of Governments (MWCOG) survey data: https://rtdc-mwcog.opendata.arcgis.com/datasets/regional-travel-survey-rts-tabulations/about. Analysis method: Kelley (2021), chap. 1, Table 3. Another dataset is the US Census Bureau's American Community Survey (ACS) in 2015 that estimates 13,091 people commute between the same jurisdictions: Kelley (2021), chap. 1, Table 5.

[51] US Census income data: Kelley (2021), chap. 2, Table 2.

19.65 million / 133,350). The factor of 148 is shown at the bottom of Figure 4.[52]

An error factor of 147 derived here from the method of Kelley (2021) is less severe than the error factor of 1,600 found in the previous section that used the method of Lysy (2021). The Kelley (2021) method, however, appears overgenerous to the maglev on several grounds.

The largest such factor is that the Kelley (2021) calculation repeated here assumes that 1.5% of all trips between Baltimore and Washington would be made on the maglev. This much more generous than the Lysy (2021) method that assumes that the entire market for high-speed rail (Acela plus the maglev) would be only 0.2% of all trips between the two cities (see the top of Figure 3). As discussed in the Willingness to Pay section above, the Acela service appears to be a more attractive option than maglev from a price vs. time-savings perspective.

A second contributing factor may be that the Kelley (2021) method merely compares ticket cost to travel-time savings. Such a calculation overestimates the value of rail travel because it does not factor in the inherent convenience of car travel that reflected in traveler's observed decisions.[53]

Other factors not yet considered would further lower the maglev ridership. Fewer maglev trips would be made in 2045 if, in the post-Covid world, many commuters teleworked most days and traveled to the office only a few days a week. Even before Covid-19 hit, the region's residents were switching to shorter commutes.[54]

Other commentary on maglev ridership

So far, the present appendix presents evidence that the official ridership forecast for the proposed Baltimore-Washington maglev is a factor of 100 or 1,000 too high. Specifically, the 2020 Louis Berger ridership report and the maglev's 2021 draft EIS both forecast an inexplicably high range of 22.4 to 24.9 million one-way passenger-trips per year.

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[52] 14.877 to 16.480 million maglev passenger-trips made by diverted car drivers in 2045: FRA (2021), chap. 4.2, Table 4.2-3, pg. 4.2-7; and Louis Berger (2020), Table 8. A somewhat different number elsewhere in the 2021 draft EIS, 15.757 to 17.490 million diverted car passenger-trips: FRA (2021), Appendix D4, Table D4-29, pg. D-45.

[53] "a simple value-of-time calculation based on annual salaries does not explain why so many commuters choose to drive:" Lysy (2021). Cars have a "convenience advantage" over high-speed rail for trips under 150-miles long: National Academies (1991), pg. 7. Compared to rail and air travel, travel by "auto has an inherent advantage in its door-to-door convenience (avoiding access and terminal time):" FRA (1997), pg. 7-4.

[54] Decrease in commuter miles driven: Washington Metropolitan Council of Governments, March 23, 2021: https://www.mwcog.org/newsroom/2021/03/23/four-travel-trends-from-the-tpbs-regional-travel-survey/.

Another fact that erodes confidence in the maglev official ridership forecast is that the CEO of BWRR likes to quote a much lower ridership number. In September 2019, CEO Wayne Rogers stated that his company's estimate for maglev ridership was under 12 million one-way trips per year. He made this statement in an interview for *Baltimore Magazine*.[55]

Similarly in 2015, Mr. Rogers wrote that the maglev ridership would be 10.2 to 15.4 million "individuals" in testimony that he submitted to the Maryland Public Service Commission. Mr. Rogers' exact words are silly because there are under 7 million individuals living in Maryland and DC, and no one thinks that they would all ride the maglev. Mr. Rogers' statement would have at least avoided being nonsense if he had used units of "one-way passenger-trips per year" rather than "individuals," although his statement would not have necessarily been accurate even then.[56]

While not quantitative, the DC Policy Center's comments on maglev ridership are relevant to this discussion:[57]

"while maglev is both technically feasible and safe, it is not a good fit for the economic and geographic needs of the Washington region, or for the Northeast Corridor in general. Maglev would not provide a very large reduction in door-to-door travel time even if it could serve central locations, such as D.C.'s Union Station or New York's Penn Station.... This is because super-fast rail speeds won't actually save passengers that much time for shorter trips, such as the trip from D.C. to Baltimore....

This additional travel time—somewhat more than an hour—is independent of train speed.... The Acela Express connects Washington and Baltimore in half an hour today, whereas JR Central says maglev would do the same trip in 15 minutes. While a 15-minute trip time between Washington and Baltimore sounds like a game changer, in reality, the total trip time (including travel to and from the stations) is likely to be more like 1:15, down from 1:30 today—only a minor improvement."

Notes on Figure 1, a Plot of Ridership vs. Ticket Price

The present blog post includes Figure 1, a plot of forecasted ridership vs. ticket price for

[55] Under 12 million maglev one-way passenger-trips per year: "Rogers parries... [s]tudies done by BWRR say a maglev could accommodate one-tenth of the nearly 120 million trips taken between the two cities annually," *Baltimore Magazine*, Sept 2019.

[56] Testimony in Case #9363: Public Service Commission (2015), Direct Testimony of Wayne L. Rogers, April 17, 2015, page 17. In 2021, 6.1 million residents in Maryland and 0.7 million in Washington, DC: US Census Bureau, State Population Totals and Components of Change: 2020-2022, https://www.census.gov/data/tables/time-series/demo/popest/2020s-state-total.html.

[57] DC Policy Center, https://www.dcpolicycenter.org/publications/is-maglev-right-for-d-c/

various ways to make the trip between Baltimore and Washington, DC. This section states the source of the figure's ridership and ticket-cost data. The maglev forecasts are plotted with circles and the forecasts for other modes of transportation are plotted with squares.

Two forecasts are plotted for the proposed Baltimore-Washington maglev. The first one comes from the 2020 Louis Berger ridership report: 22.4 to 24.9 million one-way passenger-trips in 2045. This data point is plotted as 23.65 million trips, the middle of the range. This forecast formed the basis for the maglev benefits that were calculated in the Baltimore-Washington maglev's 2021 draft environmental impact statement (EIS).[58]

The second maglev forecast was stated by Wayne Rogers, the CEO of Baltimore Washington Rapid Rail (BWRR), the company that wants to build the maglev. In 2015, Mr. Rogers' written testimony before the Maryland Public Service Commission included the statement:

> Without displacing Amtrak or the MARC train service, we anticipate that between 10.2 and 15.4 million individuals would travel annually on the SCMAGLEV between Baltimore and Washington, DC.[59]

In the quote above, Rogers uses the unit of "individual" which is the wrong unit for ridership, but Mr. Rogers is known for getting the units wrong in the figures he quotes. In the present blog post, Figure 1 plots this data point as 12.8 million one-way passenger-trips per year, which is the middle of the range that Mr. Rogers stated in his 2015 testimony.[60]

The ridership forecasts for other modes of transportation between Baltimore and Washington come from the 2015 ridership report for the 2016 NEC Future environmental impact statement. These forecasts were made under the assumption that the maglev would not be built. These forecasts are for the annual number of one-way passenger-trips in the year 2040 with Baltimore at one end of the trip and Washington at the other end of the trip. These forecasts are as follows: 2.8 million one-way passenger-trips by car; 349,000 one-way passenger-trips by regional train, which includes MARC commuter rail and Amtrak Regional trains; 93,320 one-way passenger-

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[58] 22.367–24.939 million one-way maglev passenger-trips in 2045: Louis Berger (2020), Table 8. Also found in FRA (2021), Chapter 4.2, Table 4.2-3, pg. 4.2-7.

[59] Rogers (2015), Case #9363: Public Service Commission (2015). A similar statement by Rogers of under 12 million one-way maglev passenger-trips per year in interview with *Baltimore Magazine* (Sept 2019).

[60] "16 million cars and 2 million tons of greenhouse gas," May 6, 2021, U.S. House of Representatives. Instead of "cars," the unit of "one-way passenger-trips per year" would make more sense in this context. Instead of "tons," units of either "tons/year" and "project-lifetime tons" would make more sense.

trips by bus; and 29,170 one-way passenger-trips on the Amtrak Acela high-speed train.[61]

Next, the travel cost is explained that is shown in Figure 1. The maglev's draft EIS stated that the average cost of a maglev ticket would be $60 one-way in 2018 dollars, which would be $72 in 2022 dollars after correcting for inflation.[62]

The travel cost by car is taken to be the IRS 2021 reimbursement cost of 56 cents per mile. This rate is multiplied by a distance of 44 miles by road, the distance used in the 2018 Louis Berger ridership report. This calculation works out to be $24.64 for car travel between the maglev stations. Alternatively, someone driving a car might count the cost of driving as just $3–$4 for a gallon of gas to make the trip.[63]

In 2022, the ticket price for the MARC Penn line commuter train between Baltimore Penn Station and Washington DC was $9 one-way. The price is similar for Amtrak's Regional trains in 2022: $8 to $12, one-way. [64]

A bus ticket between Baltimore and Washington costs about $13.25. This was half the price of a round-trip bus ticket in January 2023. Megabus charged $10 to $12.50 one-way with a $3.99 booking fee for an online ticket order ($13.25 = 0.5*($10+$12.50) +0.5*$4). The Greyhound-owned BoltBus service was discontinued due to the Covid-19 pandemic. In 2021, Greyhound was purchased by Flixbus who subsequently offered bus service between Baltimore and Washington. Flixbus offered $8 to $14 tickets one-way with a $3.99 service fee for online orders, so half of a single round-trip ticket would cost $13.00 (0.5*($8+$14) +0.5*$4).[65]

In December 2022, the Amtrak website listed the cost of the Acela high-speed train as $18–$23 one-way for travel between Baltimore Penn Station and Washington Union Station.[66]

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[61] FRA (2015), Appendix I, Table I-4.

[62] $60 average price in 2018 dollars: FRA (2021), Appendix D4, Table D4-27, pg. D-43. $70–79 rush-hour price: FRA (2021), Appendix D2, Table D2-35, pg. D-180. Inflation correction by CPI of x1.20 between January 2018 and November 2022: https://www.bls.gov/data/inflation_calculator.htm.

[63] 56 cents per mile: IRS (2021). 44 miles nominal distance between the Baltimore and DC maglev stations via roads: Louis Berger (2018), Section 5.3. In 2022, cars average 36 miles per gallon (mpg), and in 2026, new cars will be required to get 40 mpg: CNN, 1 Apr 2022, https://www.cnn.com/2022/04/01/energy/fuel-economy-rules.

[64] MARC Penn line fares from June 2021 through the end of 2022: https://www.mta.maryland.gov/marc-fares.

[65] https://us.megabus.com/. "Due to the impacts of the pandemic, Greyhound subsidiary BoltBus, has ceased service since March of 2020," https://www.flixbus.com/boltbus. In September 2021, FlixMobility acquired Greyhound: https://wikipedia.com, "Bolt Bus."

[66] https://www.amtrak.com

Figure 1 shows how the two maglev ridership forecasts are not only very different but also wildly higher than forecasts for all other forms of transportation. Even maglev promoters expect the maglev to capture only a small fraction of the number of passenger-trips made by car between Baltimore and Washington. Nonetheless, the official maglev ridership forecast somehow ended up being much higher than the sum of all other forms of transportation estimated the 2015 NEC Future ridership study. The Louis Berger and NEC Future ridership studies cannot both be right.

APPENDIX B: Maryland Bills

The Maryland General Assembly passed important bills about maglev technology in 2003 and 2004, and many bills about the maglev have been introduced since 2018. All of these bills are evidence of misgivings or opposition to a maglev being built between Baltimore and Washington. Information about these bills can be found on the website of the Maryland General Assembly.[67]

In 2003, an earlier effort to build a maglev between Baltimore and Washington was terminated by the Maryland General Assembly. In 2003, bill HB935 stated the following:

> (a) the state may not enter into an agreement for construction or operation of a rail system based on magnetic levitation technology except pursuant to an act of the general assembly specifically authorizing the project.
> (b) state general or special funds may not be expended for the purpose of studying, developing, or constructing a maglev system in the state." [68]

The impact of the 2003 bill was discussed in connection with bill HB733 in 2020. Specifically, this discussion stated:

> The final EIS [for the original maglev proposal in 2001] was never published, however, because State legislation enacted in 2003 and 2004 prohibited the funding of a Maglev project following the final report of the Task Force to Evaluate the Development and Construction of a Magnetic Levitation Transportation System. In its final report, which was issued in 2003, the task force noted that, among other challenges, a significant amount of funding would be required to implement a Maglev system in Maryland.[69]

In 2004, bill SB508 also prohibited spending state funds on the maglev. The prohibition on

[67] https://mgaleg.maryland.gov/mgawebsite/Search/FullText

[68] lines 15–23, page 42, House Bill 935 of the 2003 regular session, "Budget Reconciliation and Financing Act of 2003".

[69] https://mgaleg.maryland.gov/2020RS/fnotes/bil_0003/hb0733.pdf

Maryland funding for maglev studies or construction was repealed in 2011.[70]

Many bills about the maglev were introduced in the Maryland General Assembly starting in 2018. None of these bills passed.

In 2018, the Maryland General Assembly's bills HB209 and HB232 stated that Prince George's County may not condemn county land inside a municipality without a written agreement from the municipality. Bills HB232 and HB1742 stated that a company building a maglev cannot use condemnation. Bills HB637/SB1004 and HB638/SB1005 established requirements about maglev hearings. Bill HB1742/SB1003 stated that no maglev can be built in a Maryland county unless the county approves.

In 2019, bill HB0559 stated that any company building a maglev cannot condemn property to do so. Bill HB765/SB0914 stated that a company building a maglev must first obtain informed consent of majority of the government bodies in the affected counties.

In 2020, bill HB733/SB526 stated that the Maryland Secretary of Transportation must designate an ombudsman to give out timely information to the public related to projects such as building a maglev. Bill HB715/SB253 prohibited "a public or private entity that receives money from the State from authorizing a permit or giving any other form of approval for a magnetic levitation transportation system in the State." Bill HB1238 limited the ability of property condemnation being used in connection with building the proposed maglev.

In 2021, bill HB0063/SB0188 forbid state funds from being spent on a maglev. Bill HB704 stated that, statewide, no maglev shall be built within 2 miles of a house or several other types of property. This bill even forbad land from being condemned for the maglev near these types of property. Bill HB622 was similar to bill HB704 except specific to Prince Georges County.

In 2022, bill HB0120 stated that a company building a maglev can't use condemnation. Bill HB0326/SB0359 prohibited the state from funding maglev design or construction. Bill SB1013 stated that, if a company building a maglev condemns any land, then that company must pay an amount equal to 25% of the purchase price to a local development council.

In January 2023, bill HB0106/SB50 was introduced, which is a reintroduction of the 2022 bill HB0326. This bill forbad state funds from being used on the maglev, with a limited exception for personnel costs associated with reviewing documents.

[70] The year 2004 bill SB508 is described as follows: "a provision was adopted in Senate Bill 508 prohibiting the State from expending any funds from any source for the purpose of studying, developing, or constructing a Maglev system effective July 1, 2005:" memo from Karl S. Aro to Senator Mike Miller, "The 90 Day Report", April 15, 2004, https://mgaleg.maryland.gov/Pubs/LegisLegal/2004rs-90-day-report.pdf.

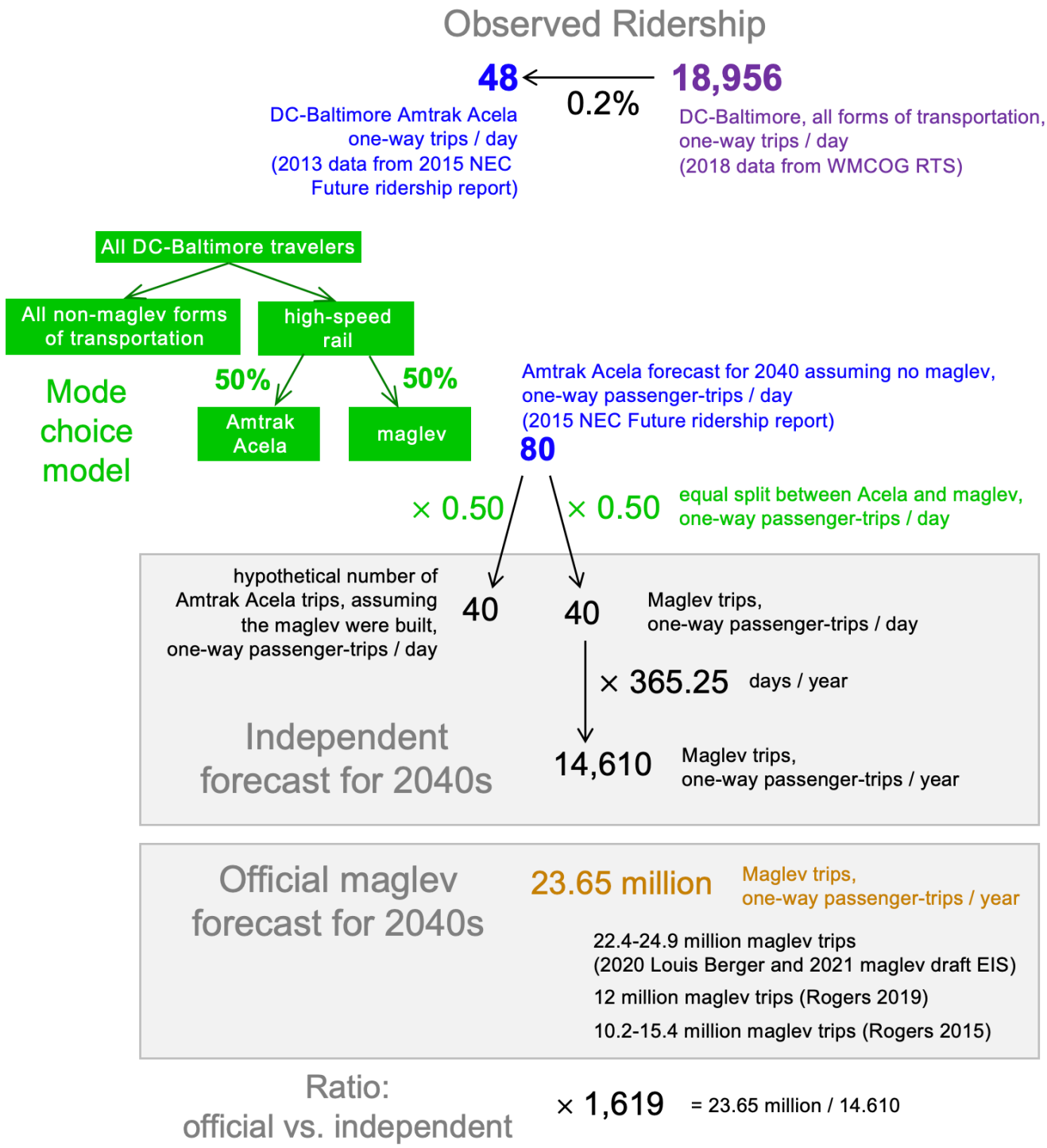

Figure 3. A schematic diagram showing how the Amtrak Acela forecast in the NEC Future ridership report suggests that the official maglev ridership forecast appears more than a factor of 1,000 too high. The official maglev forecast is stated in the 2020 Louis Berger ridership report and 2021 maglev draft EIS.

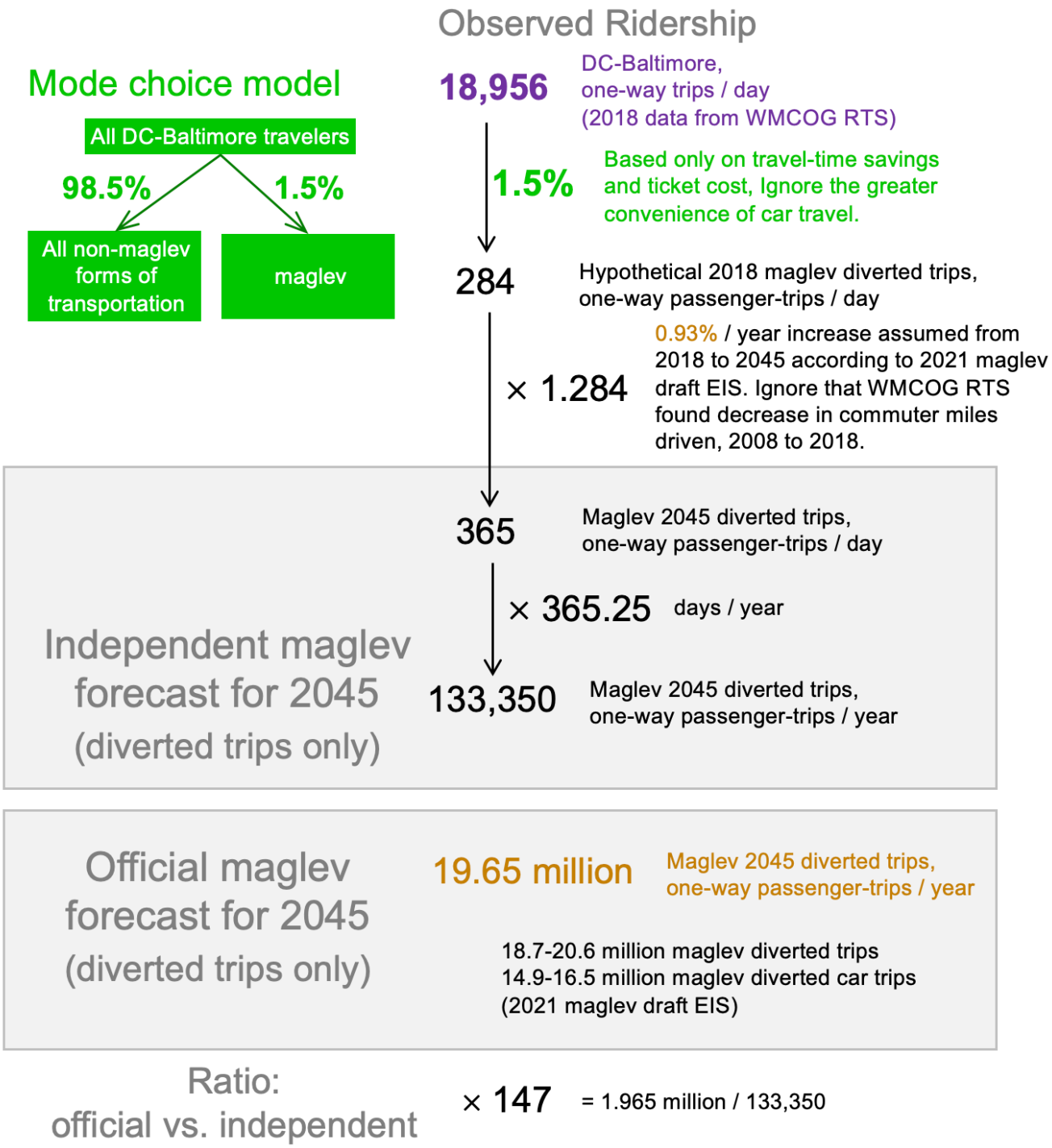

Figure 4. A schematic diagram showing how the MWCOG Regional Travel Survey suggests that the official maglev ridership forecast is more than a factor of 1,000 too high. The official maglev forecast is stated in the 2020 Louis Berger ridership report and 2021 maglev draft EIS. This calculation from the Regional Travel Survey may be too generous to the maglev because it only considers travel-time savings and costs of various forms of transportation and ignores the inherent convenience of car travel.