# Transportation Resilience Benefit-Cost Analysis Case Study

# Transit: Rail Stop

## Case Study

**Overview:** The National Capital Region Transportation Planning Board (TPB) conducted five benefit-cost analysis (BCA) case studies of transportation assets within the National Capital Region to demonstrate the cost of inaction, compare low-cost and high-cost solutions, and provide support for the benefits of proactive resilience investment.

### Key Takeaways

- Heat and flood impacts pose a risk to commuters that can be abated by proactive investments.
- Over 20 years, non-investment could result in nearly $3,000 in heat-related health impacts at Greenbelt station.
- Results suggest a 1.07:1 ROI for proactive investment in a low-cost heat and nuisance flooding solution.
- Similar action could be taken at a regional level to address health and infrastructure concerns in the National Capital Region.

**Study Site:** The focus of this case study is Greenbelt station in Greenbelt, MD. This station is served by both Maryland Area Rail Commuter (MARC) and Washington Metropolitan Area Transit Authority (WMATA) and serves roughly 2,100 passengers per day during the summer (2,060 WMATA[i] and 30 MARC[ii]). The site also contains a WMATA railyard which has capacity for 284 railcars[iii] and is a potential location for the future FBI headquarters.[iv]


*Aerial view, Greenbelt Station (Google Maps)*

**Context:** The MARC station at Greenbelt is exposed to the elements; studies show that exposure to extreme heat results in increased healthcare costs, and that heat event days are expected to increase across the region.[v] Research suggests that shelters can help mitigate health impacts from heat.[vi] Historically, the Greenbelt station and railyard are also at risk of flooding.[vii] This case study examines a low-cost solution to address heat and minor flooding impacts, and a high-cost solution for mitigating future flood impacts.

**Results:** BCA results suggest that the low-cost and high-cost solutions have discounted (3.1%)[viii] benefit-cost ratios of 1.07 and 0.85, respectively. These results imply that for every $1 invested, the low-cost solution will return about $1.07 in health and flooding response benefits. The high-cost solution would result in about $0.85 in benefits per dollar invested. Net benefits for the low-cost solution are estimated at around $1,100 over 20 years.

**Methods:** This analysis uses data on regional heat event days to identify summer health impacts at the Greenbelt station. Assuming health care costs of about $750 for ED visits, hospitalization costs of about $15,000,[ix] and roughly 30 commuters per day,[x] the no action heat-related health impacts at this station are estimated to cost $2 per day, or $163 per summer. The analysis assumes that this cost will grow annually by 3.6 percent based on regional climate data.[xi]

For no action flooding impacts, the analysis assumes that nuisance flooding occurs 10 times per year. For each event, station staff are assumed to spend 0.5 hours setting up signage to avoid flooded or slippery areas and one hour deploying a pump to remove standing water (an equipment cost of $35 per event,[xii] and a loaded hourly wage of $41.44[xiii]) amounting to an annual cost of $972. Examining flood data[xiv] along the track, station footprint, and railyard footprint, this analysis identified that 100-year and 500-year storms result in flooding along the embankments. While definitive flood risk is unknown, this analysis assumes that there is a 1% cumulative risk, starting after 10 years, of a section of track failing due to flooding. This failure would result in significant repair and loss of function costs. Assuming 1,200 feet of track replacement, at a cost of $300,000 per mile,[xv] results in roughly $68,000 in repair costs. While the track is being repaired, there would be significant loss of function costs as MARC trains would need to be replaced with buses. This loss of function cost, for one month of service, is estimated at roughly $2.9 million ($2.4 million in increased travel time, and $500,000 in bus and driver costs). These estimates are based on daily C-line ridership (4,500),[xvi] bus capacity (55 persons),[xvii] distances between Muirkirk and Greenbelt (eight miles or 15 minutes) and Greenbelt and College Park (five miles or 15 minutes),[xviii] a value of travel time of $21.72,[xix] and bus driver salaries of $30 per hour.[xx]

For the low-cost solution, this analysis assumes the installation of electronic signage identifying the heat index, suggesting commuters stay in the cool shade of the tunnel, and noting when the MARC train is arriving and commuters should proceed to the platform. The analysis assumes that installation of this signage would cost $5,000 and would eliminate 75% of heat-related station health impacts. To address nuisance flooding, the analysis assumes the low-cost solution would include slope grading ($450 at $9 a square foot for 50 square feet)[xxi] and drainage systems ($10,000 installation cost) which are assumed to eliminate nuisance flooding impacts. For the high-cost solution, this analysis is focused on eliminating, to the extent possible, heat-related health impacts through the installment of track-side shelters ($8,300 per shelter)[xxii] and addressing the large-scale erosion impacts of 100-year and 500-year storms by hardening embankments (roughly $1,000 per linear foot).[xxiii] This analysis assumes that hardening the railway embankment will eliminate the 1% cumulative failure risk.

**Detailed Results:** Results indicate that the no-action scenario leads to roughly $3,000 (discounted at 3.1%) in health impacts over a 20-year period. Proactive investment provides a health cost-savings over the same period of $1,800-$2,200 by lowering ambient temperatures. Nuisance flooding mitigation in the low-cost solution would lead to about $14,000 in gross benefits over 20 years. The low-cost solution generates roughly $1,100 in net benefits over 20 years with a benefit-cost ratio (BCR) of 1.07, discounted at 3.1%. The high-cost solution, which includes the investments of the low-cost solution plus investment to prevent long-term flooding, is estimated to result in about $117,000 in net costs over 20 years with a BCR of 0.85, discounted at 3.1%.

**Qualitative Benefits:** The results presented above are conservative, and likely represent a lower bound for potential benefits and return on investment. Additional unmonetized benefits are expected to accrue from proactive investment. Heat events are also expected to result in increased ambulatory

care responses (without hospital visits), but data were unavailable to monetize this impact. The signage and shelters proposed to mitigate heat-related effects would also likely lead to other weather-related health benefits (*e.g.*, extreme cold, inclement weather), which were not quantified in this analysis.

**Regional Implications:** There are several rail stations in the National Capital Region with similar characteristics to Greenbelt station: locations served by MARC and other agencies that are unsheltered and susceptible to the elements, at risk of high temperatures, and in 100-year or 500-year floodplains. Between June and August of 2024, the average ridership for all MARC lines was about 360,000 per month, or about 12,000 riders per day.[xxiv] If transit agencies in the National Capital Region emulated the low-cost investments proposed for Greenbelt station at stations serving even just 10% of these 12,000 daily MARC commuters, the health impact and flooding savings to the region could be roughly $93,000 (discounted at 3.1%) over 20 years.

[i] Washington Metropolitan Area Transit Authority. Ridership data portal. https://www.wmata.com/initiatives/ridership-portal/
[ii] Maryland Transit Administration. MARC Trains Stations – MTA Fiscal Year 2024. https://data.imap.maryland.gov/datasets/maryland-transit-marc-trains-stations/explore
[iii] Greater Greater Washington. Hitachi enters the region while Metro plans for all 8-car trains. 2022. https://ggwash.org/view/85259/hitachi-enters-the-dc-region-while-metro-plans-for-all-8-car-trains
[iv] U.S. General Services Administration. FBI Headquarters Consolidation. 2025. https://www.gsa.gov/about-us/gsa-regions/region-11-national-capital/buildings-and-facilities/development-projects/fbi-headquarters-consolidation
[v] Woolf, S., Morina, J., French, E., Funk, A., Sabo, R., Fong, S., Hoffman, J., Chapman, D., & Krist, A. (2024). The health care costs of extreme heat. Center for American Progress. https://www.americanprogress.org/article/the-health-care-costs-of-extreme-heat/
[vi] Lanza, K., Ernst, S., Watkins, K., & Chen, B. (2025). Heat stress mitigation by trees and shelters at bus stops. Transportation Research Part D: Transport and Environment. 140: 104653 https://doi.org/10.1016/j.trd.2025.104653
[vii] WMATA. Greenbelt Joint Development Environmental Evaluation. 2015. https://www.wmata.com/about/public-hearings/upload/5-Environmental-Evaluation.pdf
[viii] A discount rate is a rate used to determine the present value of future cash flows. As of 2025, the U.S. Department of Transportation recommends a discount rate of 3.1%.
[ix] *Ibid.*
[x] Maryland Transit Administration. MARC Trains Stations – MTA Fiscal Year 2024. https://data.imap.maryland.gov/datasets/maryland-transit-marc-trains-stations/explore
[xi] NOAA. (n.d.). NOWData – NOAA Online Weather Data. National Weather Service. https://www.weather.gov/wrh/Climate?wfo=lwx
[xii] Assumption based on a 4-hour pump rental from home department store: Home Depot: https://www.homedepot.com/p/rental/Submersible-Pump-2-in-Rental-9112/316822084.
[xiii] Based on an hourly rate for a maintenance worker (https://data.bls.gov/oesprofile/) and a loading factor (https://www.bls.gov/news.release/pdf/ecec.pdf) from the Bureau of Labor Statistics.
[xiv] Based on MWCOG analysis of Fathom flood data: https://www.fathom.global/
[xv] Based off Purple line and Silver line extension projects. Both projects cost roughly $5B-$6B each for 16-mile and 23-mile extensions, respectively. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/funding/grant-programs/capital-investments/69851/md-purple-line-ffga-fy19-profile.pdf & https://www.fhwa.dot.gov/ipd/value_capture/resources/value_capture_resources/edc-5_resources/webster_rail_b.aspx
[xvi] Maryland Transit Administration Open Data Portal. GOPI Resource MM – MTA Average Weekday Ridership. https://opendata.maryland.gov/dataset/GOPI-Resource-MM-MTA-Average-Weekday-Ridership/t2jw-tiu2/data_preview
[xvii] DC Chart Bus Company. (February 2024). Complete Guide to Charter Bus Rentals in Washington D.C. https://www.dccharterbuscompany.com/blog/complete-guide-charter-bus-rentals-washington-dc/
[xviii] Shortest distance between, per Google Maps. https://www.google.com/maps
[xix] Calculated based on 2023 hourly value of travel time savings of $21.10, from U.S. DOT BCA guidance Table A-2: Value of Travel Time Savings. https://www.transportation.gov/sites/dot.gov/files/2024-11/Benefit%20Cost%20Analysis%20Guidance%202025%20Update%20%28Final%29.pdf.
2023 value * (2024 inflation adjustment value / 2023 inflation adjustment value) = $21.10 * (313.689/304.702) = $21.72 (2024$).
[xx] WMATA. Become a Metrobus driver. No experience needed. https://www.wmata.com/about/careers/become-a-metrobus-operator.cfm
[xxi] Estimated based on a variety of sources. See, *e.g.,* https://royalrestorationdmv.com/flood-restoration-cost.
[xxii] Loudoun County Finance/Government Operations and Economic Development Committee. (December 10, 2024). Update on Stop Improvements and Bus Shelter Program. https://loudoun.granicus.com/MetaViewer.php?view_id=77&clip_id=7843&meta_id=255383
[xxiii] $1,000 per linear foot is a conservative estimate accounting for various strategies of varying costs that can be used to harden embankments and prevent erosion, such as installation of riprap stone.
[xxiv] Maryland Transit Administration. MTA Performance Improvement. https://www.mta.maryland.gov/performance-improvement

This analysis includes a detailed benefit cost analysis model assessing quantified costs and benefits. For additional information on this case study, or to assess your own site for transportation resilience, please reach out to Katherine Rainone at krainone@mwcog.org.