How high would an emissions disbursement stack have to be if an aluminum recycling plant was set in a valley with one river for runoff, the plant will be at the river elevation, the valley is 19 miles wide and the height of the valley from the river bottom is 600 foot into the valley and 1200 foot out of the valley as prevailing wind goes

The required height for an emissions stack at an aluminum recycling plant in a valley—specifically to comply with EPA Good Engineering Practice (GEP) guidelines and to limit the risk of pollutant downwash into the valley or river—typically relies on formulas set by the EPA. The primary goal of these regulations is to ensure that the emissions do not result in excessive concentrations of pollutants near ground level, especially in complex terrain or near water sources.

EPA Stack Height Guidelines

The EPA defines "good engineering practice" (GEP) stack height as the greater of:

- 65m (213ft) above the ground at the base of the stack,
- OR, for new or un-permitted stacks:

  $$Hg = H + 1.5L$$

  Where:
  - $ Hg $: Required GEP stack height above base elevation,
  - $ H $: Height of nearby "structure" or terrain feature above base,
  - $ L $: Lesser of the height or width of that feature [1] [2] [3] [4] [5].

Applying to Your Valley Scenario

Valley Parameters:

- Valley is 19 miles wide.
- River is at the valley floor; plant is at river elevation.
- Slope rises 600ft upwind; 1,200ft downwind (prevailing wind direction).

The EPA generally treats *terrain* like a building for GEP calculations if the terrain (valley wall) is nearby and taller than the source (the plant and its stack).

- The stack **at the river** would be *below* both valley walls (600ft and 1,200ft), and is thus subject to the terrain influence.
- For stack height, the "nearby structure" is the valley wall in the direction of prevailing wind: **1,200ft high**.

EPA GEP Calculation Example:

- If the upwind terrain (1,200ft high) is considered "nearby," use the formula:
  $$Hg = H + 1.5L$$
  Where both $ H $ and $ L $ could be 1,200ft (if the height is less than or equal to the width considered).
  So, for a conservative estimate:
  $$Hg = 1,200\,ft + 1.5 \times 1,200\,ft = 1,200\,ft + 1,800\,ft = 3,000\,ft$$

But, the EPA stipulates that stack height should not exceed that needed to avoid excessive pollution concentrations and specifically states that a field study or fluid model might allow for a lesser height than this theoretical number. It also mentions that, for most cases (even with nearby terrain), a stack of **65m (213ft)** meets "de minimis" standards unless terrain is significantly complex and a field/modeling study demonstrates that more height is necessary [1] [2] [3] [4] [5].

Key Notes:

- In complex terrain like your scenario, an air quality model or fluid field study is often required to justify either a lower or higher stack than the basic formula.
- **Default minimum GEP stack is 65m (213ft)** unless terrain modeling demands taller [1] [2] [3] [4] [6] [5].
- The theoretical stack height based just on 1,200ft terrain is **up to 3,000ft**, but this is *almost never* constructed due to engineering, modeling, and cost constraints—the real-world stack would be justified by EPA air quality modeling.

Practical Next Steps

A site-specific air dispersion modeling (following EPA guidelines) would determine the minimum required stack height considering valley effects, wind, topography, and proximity to the river. The *theoretical maximum* using EPA's formula is 3,000ft in your case; however, real stacks typically range from 65m up to a few hundred feet unless modeling shows more is needed [1] [2] [3] [4] [5] [6].

References:
[1] [2] [3] [4] [5] [6]

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Effects of valley terrain on dispersion

Valley terrain significantly affects pollutant dispersion through several key mechanisms related to the valley's unique topography and meteorology:

1. **Flow Channeling and Stagnation:** Valleys act like natural channels where wind flow is constrained by the valley walls, limiting lateral dispersion. This channeling can lead to air stagnation in the valley bottom, trapping emissions near the source and increasing pollutant concentrations.
2. **Thermally Driven Local Circulations:** Valleys experience mountain and valley breezes caused by daytime heating (anabatic winds) and nighttime cooling (katabatic winds). These circulation patterns can recirculate pollutants within the valley, enhancing accumulation especially during stable atmospheric conditions.
3. **Temperature Inversions:** In valleys, especially during nighttime and winter, temperature inversions commonly form. These inversions create a "lid" that suppresses vertical mixing of air, trapping pollutants close to the valley floor and exacerbating pollution episodes.
4. **Recirculation Zones:** Complex valley terrain induces zones where airflow recirculates or becomes stagnant. These zones can cause pollutants to accumulate more heavily compared to areas with better ventilation.
5. **Reduced Vertical Mixing and Ventilation:** The combination of stable atmospheric conditions, flow blockage by terrain, and limited cross-valley winds reduces the mixing and dispersal of emissions, leading to prolonged pollution events.
6. **Impact of Synoptic Winds:** Larger-scale synoptic wind patterns can either enhance or diminish valley effects depending on their direction and strength. Favorable winds can ventilate the valley, while opposing winds can reinforce stagnation.

Overall, valleys often experience higher pollutant concentrations due to limited dispersion capabilities caused by terrain-induced flow alterations and thermal effects. This phenomenon makes emission control and stack height considerations critical in valley locations to mitigate pollution build-up[21] [22] [23] [24] [25] [26] [27].

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1. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000MXYW.TXT
2. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=910113X8.TXT
3. https://www.epa.gov/sites/default/files/2018-07/documents/chapter_3745-16.pdf
4. https://journals.library.wustl.edu/urbanlaw/article/8476/galley/25309/view/
5. https://www.valleyair.org/media/zlbhrg22/modeling_guidance.pdf
6. https://gaftp.epa.gov/aqmg/SCRAM/mchisrs/22-II-03_Region2_MCHRequest_AlcoaMassena.pdf
7. https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-51/appendix-Appendix W to Part 51
8. https://www.epa.gov/sites/default/files/2015-08/documents/pvec-application-nov2008.pdf
9. https://www.recyclingtoday.com/news/opponents-cite-fears-about-proposed-smelter/
10. https://www.valleyair.org/media/glsdzpx3/capcoa_hra_lu_guidelines_8-6-09.pdf

11. https://burnley.gov.uk/wp-content/uploads/2023/08/6-supporting-document-Stack-Height-Analysis.pdf
12. https://www.youtube.com/watch?v=axYcIdx31XU
13. https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-266/subpart-H/section-266.106
14. https://www.maricopa.gov/DocumentCenter/View/64549/Permitting-Handbook-PDF?bidId=
15. https://dtsc.ca.gov/wp-content/uploads/sites/31/2021/08/2021.08.09_Metal_Shredder_Analysis.pdf
16. https://www2.deq.idaho.gov/admin/LEIA/api/document/download/15925
17. https://www.baaqmd.gov/~/media/files/planning-and-research/permit-modeling/pmt_modeling_guidance.pdf
18. https://extapps.dec.ny.gov/docs/materials_minerals_pdf/ogdsgeischap6.pdf
19. https://pmc.ncbi.nlm.nih.gov/articles/PMC10220784/
20. https://www.kgun9.com/news/community-inspired-journalism/cochise-county/growing-pains-aluminum-recycling-plant-causing-mixed-feelings-in-benson-separating-the-city-and-residents
21. https://pubmed.ncbi.nlm.nih.gov/40684833/
22. https://www2.dmu.dk/atmosphericenvironment/cost/docs/cost710-4.pdf
23. https://www.tunley-environmental.com/en/white-papers/complex-terrain-and-particle-dispersion-white-paper
24. https://www.iowadnr.gov/media/2181/download?inline
25. https://www.sciencedirect.com/science/article/abs/pii/S0269749124019420
26. https://www.sciencedirect.com/science/article/abs/pii/S0269749125012217
27. https://agupubs.onlinelibrary.wiley.com/doi/10.1029/1999JD900999