Julie A Wycoff

To summarize...

I am in the county down river from the proposed Aluminum Site. I have thought alot about the topography of our valley which could be quit challenging for the proposed 100 foot stacks. In my research it appears that in a nice flat environment, even only 100 foot stacks, could emit a plume that can carry persistent toxins very far from the site and surrounding drainage systems. Based on the laws of physics, it would lift the heated plume high and send it far. However, when I drive into Benson from Tucson and see our very narrow and very deep valley, I can easily see there could be some challenges with that dispersion model happening correctly here.

The topography of the San Pedro River Valley in the Benson vicinity, as you likely know, is a huge drainage system. From J6/Mescal Road (Elevation 4214ft) down to the river bottom (3530 ft elevation) then back up to Dragoon Road (Elevation 4735ft) is only about 20 miles as the crow flies. That is a 670 foot drop into the valley from J6/Mescal to the proposed site (a large portion of that drop occurs within a mile of benson). Then a 1205 foot gain in elevation back out of the valley to dragoon road. (This measurement is only from I10 and dragoon exit...not the top of the peak of the Dragoon Mountain range that extends from Tombstone (Middlemarch Road) to significantly north of Benson Arizona, making this a conservative estimate in height) That means that from the proposed 100ft distribution stacks in Benson heading east it gains at least 1205 foot in only 12 miles, likely more than 100 foot per mile considering the height of the mountain range itself. From the west by J6/Mescal Road it drops in elevation 670 feet into the San Pedro River valley in only 8.68 miles with most of that drop sudden and within a mile of Benson. Prevailing winds typically from the south southwest, so usually from J6 towards Benson and continuing east-north east from there towards Dragoon Road and the Dragoon Mountain range where it navigates through and over.

With consideration to the valley topography, wind, climate and proximity to the river... we as residents downstream from Benson are concerned with the valley acting like natural channels where the wind flow constraints could limit the dispersion outside the valley, trapping persistent toxins within our valley drainage which is about 20 miles across. I have used a leaf blower enough to know that there is stagnation... seems reasonable to assume that could also be reflected within the valley river bottom which could trap emissions near the proposed plant, over Benson and over the nearby surrounding slopes of the Dragoon Mountain Range increasing pollutant concentrations.

Also with the daytime heating and nighttime cooling... which Benson is famous for... these pollutants likely will continue to be recirculated within the valley, adding to the concentration of these persistent chemicals.

So, to further complicate the issue... Temperature inversions in valleys, usually during nighttime and wintertime where the weather cools (and Benson is classic for this all year) can create a lid effect further trapping particulate into our valley drainage system. This is evidenced by what we all see in the wintertime with the woodstove smoke. Here in Benson we have nighttime freezes from October through March most every night and cooler weather the rest of the year in the evenings ... If you leave Benson early in the morning when the weather is still cold, all the woodstove smoke is trapped low settling along the San Pedro River Valley... over Benson, out to Pomerene and South

towards St. David. If we apply the same principals to the 100 foot distribution stacks... it stands to reason that it will react the same. Meaning the plume will be trapped low settling along the San Pedro River Valley... over Benson, out to Pomerene and South towards St. David. This will drastically increase the potential for further trapping of pollutants close to the valley floor... creating a situation of greater distribution of persistent chemicals from the stacks. This means that particulate of persistent toxins will be distributed all around Benson, south towards St. David and north towards Pomerene. This topography and climate coupled with the stack height seems very likely to concentrate pollutants within the 20 mile on river drainage system at a higher rate than a flat terrain.

According to my research, valleys experience higher distribution of pollutants and persistent chemical concentrations. Benson topography, climate, and prevailing wind dictates this will be a prime candidate for excessive accumulation of persistent chemicals within our one river drainage system.

Now what about precipitation? We are dry most of the year. Couple this with occasional torrential rains during the Monsoon Season. This will eventually wash all of these concentrated pollutants that have been recirculated and deposited within our 20 mile wide drainage system into the river bed... and downstream in highly concentrated amounts... towards all of us who live just down river from Benson. This then could create an acute environmental emergency for the San Pedro River Valley and local wells.

Ok curious then....

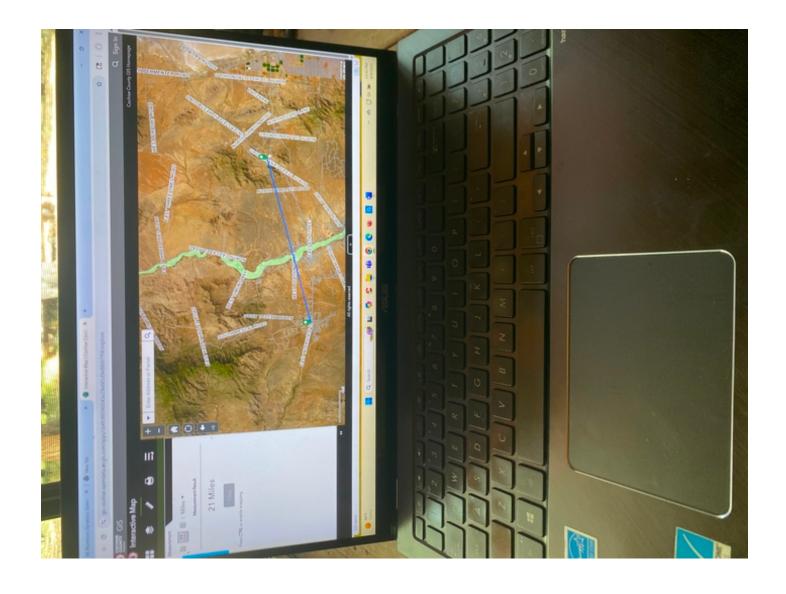
Will the EPA be doing site-specific air dispersion modeling to help to determine the minimum required stack height?

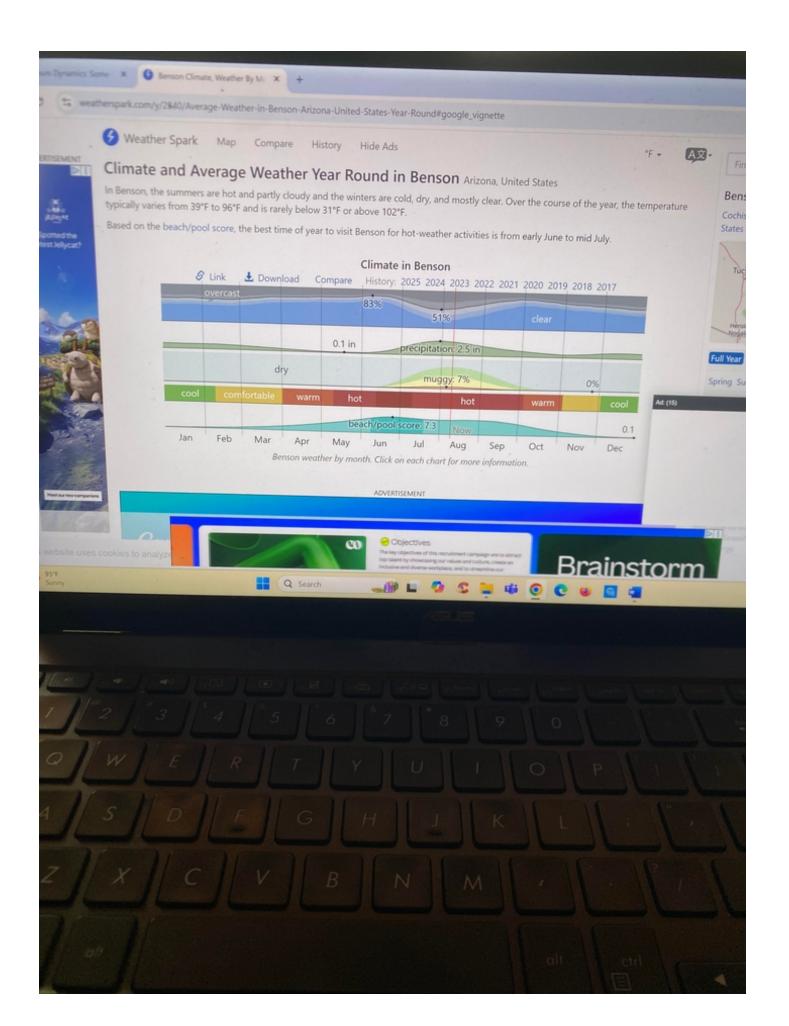
What safety measures will the EPA be imposing considering this particular valleys topography, wind, climate and proximity to the river?

Will the EPA be taking soil samples routinely within this one river drainage system to ensure there will be no potential for an acute environmental disaster downstream?

How often would those samples be taken? Will they be made public?

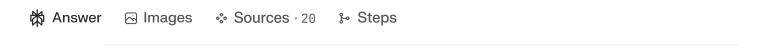
Thank you for all your efforts in this matter~







Soil near an an aluminum recycling plant in an environment with no runoff other than down one river and very little rainfall. What are the effects on the environment under these circumstances?



Soil near an aluminum recycling plant, especially in an environment with little rainfall and only a single river for runoff, can experience several negative environmental effects:

1. Heavy Metal Contamination

Aluminum recycling processes and associated metal recycling activities tend to release elevated levels of heavy metals into surrounding soils. Studies have shown localized enrichment of metals such as lead (Pb), zinc (Zn), copper (Cu), chromium (Cr), cadmium (Cd), and sometimes nickel (Ni) near such facilities. These metals can accumulate in soil due to atmospheric deposition (dust/particulates), improper handling of waste, or leaks and spills from processing activities. Lead and zinc often present the highest contamination risks, which can persist in soils for many years, particularly when rainfall is low and flushing of pollutants is minimal 1 2 3.

2. Effects on Plants and Soil Health

High concentrations of aluminum and other heavy metals in soil can severely affect plant growth, particularly in acidic conditions (pH below 5). Aluminum phytotoxicity can inhibit root growth and reduce water and nutrient uptake, limiting productivity and potentially eliminating more sensitive plant species. This impacts the local plant community and can alter the ecosystem structure 4 5.

3. Ecological Impact on Soil and River

With only one river as a route for runoff, heavy metals and other contaminants can accumulate in the surrounding soil, leading to a high risk of eventual leaching into the river. Over time, as rain or stormwater runoff occurs, even infrequently, these contaminants may enter the river, posing risks to aquatic life and downstream ecosystems. Such metals can bioaccumulate in fish and wildlife, potentially causing ecosystem-level toxicity 6 2.

4. Limited Rainfall - Accumulation Rather Than Dilution

In environments with minimal rainfall, the dilution and flushing of contaminants is limited. This means that soil near the plant can experience long-term accumulation of toxic metals, making the effects more localized but persistent. The slow movement of pollutants also raises the risk that one-off flooding or heavy rain could result in a pulse of contamination into the river, causing acute ecological effects downstream $\frac{\pi}{2}$.

5. Health Risks to Humans and Wildlife

Persistent heavy metal contamination poses risks for human health, especially if local crops are grown in contaminated soil or if dust becomes airborne and inhaled by nearby residents. Wildlife, too, may be affected through direct soil contact, ingestion of contaminated vegetation, or through river water and its food web 1 2 7.

Summary Table: Key Environmental Effects

Effect	Explanation
Heavy metal contamination in soil	Elevated levels of Pb, Zn, Cu, Cr, Cd, Ni 1 2 3
Plant toxicity and stunted growth	Aluminum and heavy metal toxicity, especially in acidic soils
River and aquatic ecosystem risk	Potential for metal leaching and bioaccumulation 6 2
Long-term accumulation due to low rainfall	Little dilution or runoff increases local persistence 7 2 8
Risk to human health	Direct or indirect exposure via soil, crops, dust, water 1 7 2

In summary, soil near an aluminum recycling facility in a dry environment with only one downstream river is at risk for serious and persistent heavy metal buildup, soil health degradation, threats to plants and local biota, and potential long-term risks to both ecosystems and people downstream. Proper monitoring and remediation strategies are essential in such settings to mitigate these environmental impacts.

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Soil acidity changes near recycling facilities

微	Answer	Images	Sources - 10	⊱ Steps
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Soil acidity changes near recycling facilities can vary, but there are some key patterns and explanations observed in studies:

- Soil near recycling centers can show differing pH levels compared to natural or less disturbed areas. One study found the soil close to a recycling center to be less acidic (closer to neutral pH) than surrounding forest soils, which were more acidic. This difference was attributed to the impact of the recycling center's outputs and reduced vegetation near the facility 1.
- Elevated levels of aluminum, which is often associated with acidic soils, may be present near recycling facilities. However, the timing of contamination and other environmental factors like rainfall can influence whether pH levels become more acidic or not 1.
- Soil acidification generally involves increases in soil acidity (lower pH) and can lead to increased bioavailability of toxic elements like aluminum and manganese, reduced availability of essential nutrients, and negative effects on soil biological functions and plant growth 3.
- Other anthropogenic influences near recycling sites, including traffic emissions and nitrogen compounds (e.g., ammonia, nitrate), can influence soil acidity via complex chemical and biological processes related to nitrogen cycling 1.
- Composting or organic matter inputs near recycling or waste management sites might
 moderate soil acidity, tending to bring pH levels closer to neutral by microbial decomposition
 and release of alkaline compounds, although this is more relevant in managed situations or
 with specific organic inputs 4.

In summary, soil acidity near recycling facilities can be influenced by various factors including metal contamination, nitrogen emissions, vegetation cover, and potential organic matter inputs, leading to localized changes that can be either more acidic or closer to neutral depending on site-specific conditions 1 3 4.

If you want more specific details or examples related to aluminum recycling plants or a particular environment, I can help find additional information.



≡ Related

Effects of recycling on soil mineral content	+
Long-term recovery of soil pH after pollution	+
Role of organic amendments in soil remediation	+
Differences in soil acidity between urban and rural areas	+

Impact of soil acidification on local water quality +

Ask a follow-up...

Q >



How high would an emissions disbursement stack have to be in if an aluminum recycling plant was set in a valley next to the river with an elevation out of the valley 670 foot to the west and over 1200 feet to the east with the valley being 20 miles wide and having only one river for runoff running through the valley.

An emissions disbursement stack for an aluminum recycling plant set in a valley with the geographic characteristics you've described would need to follow "Good Engineering Practice" (GEP) stack height guidelines to ensure the emissions disperse properly and meet air quality standards.

GEP stack height is calculated to prevent excessive concentrations of pollutants due to downwash, wakes, or eddy effects caused by terrain and nearby structures. The height is generally the greater of:

- 1. A minimum set height (commonly around 65 meters or approximately 213 feet) measured from the ground elevation at the base of the stack.
- 2. A formula-based height: Hg = H + 1.5L
 - Hg = GEP stack height
 - H = height of the nearby structure or terrain feature measured from the base of the stack
 - L = the lesser of the height or projected width of the nearby structure or terrain

Given your specific scenario:

- The valley floor is lower compared to the terrain on either side (670 feet elevation rise to the west, and over 1200 feet to the east).
- The valley is approximately 20 miles wide with a river running through it.

To accommodate this topography:

- The stack height should at least exceed the surrounding terrain height on the valley sides to allow emissions to disperse above the elevated terrain which creates potential for pollutant trapping.
- Practically, the stack height could be designed to be somewhat higher than the tallest adjacent terrain (i.e., over 1200 feet) or based on detailed dispersion modeling (fluid or field

studies) approved by regulatory authorities. This modeling accounts for the influence of the valley shape on airflow and pollutant dispersion.

• The 1.5L in the formula is generally applied to building or structure widths but when terrain features dominate, the terrain height is taken into account.

In conclusion, for the aluminum recycling plant in a 20-mile wide valley with surrounding terrain rises of 670 to over 1200 feet, the emissions stack would likely need to be at least on the order of **1200 feet or higher**, or a height derived from a site-specific air dispersion study ensuring emissions rise above the valley terrain to avoid pollutant accumulation. This would be confirmed by a regulatory field study or fluid model showing compliance with air quality standards.

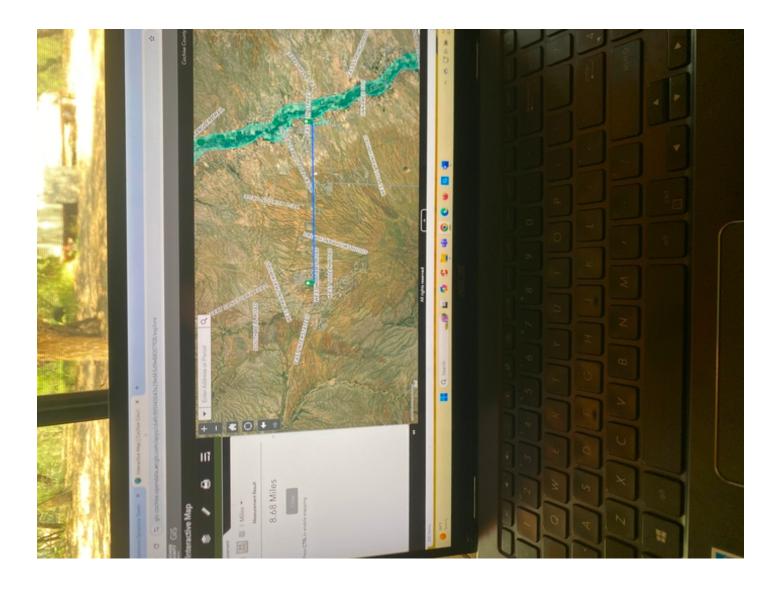
Regulatory guidance generally refers to such practice and allows adjustments based on site-specific studies to optimize stack height for environmental safety [1] [2] [3] [4].



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- 4. https://www.ecfr.gov/current/title-40/chapter-l/subchapter-C/part-51/subpart-G/section-51.118
- 5. https://ia.cpuc.ca.gov/environment/Attach 4_07-A Phase I ESAs.pdf
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Would it be reasonably prudent to build an aluminum recycling plant was set in a valley next to the river with an elevation out of the valley 670 foot to the west and over 1200 feet to the east with the valley being 20 miles wide and having only one river for runoff running through the valley with very little rainfall and torrential rains and flooding 3 months of the year

Building an aluminum recycling plant in a valley with the characteristics you described involves significant risks that need careful consideration, particularly related to flooding and runoff.

Key factors to consider include:

- **Flood Risk**: The valley has a single river for runoff and experiences torrential rains and flooding for about three months a year. Floodwaters can cause physical damage such as erosion of foundations, structural collapse, and interior damage. These risks require mitigation strategies like elevated foundations and flood-resistant materials.
- **Site Elevation and Topography**: The valley has elevation rises of 670 feet to the west and over 1200 feet to the east, with the valley being 20 miles wide. While the elevation may provide some protection, building near a single river with flood potential still poses risks unless the plant is elevated significantly above the base flood elevation (BFE).
- **Minimal Rainfall Outside Flood Season**: The minimal rainfall outside the flooding season means water flow is concentrated during those few months, likely increasing flood intensity. This periodic flooding can be very damaging if not properly planned for.
- Floodplain Construction Requirements: Building in a flood zone typically demands elevated foundations (such as piers or piles), waterproof construction materials, and proper drainage systems to divert floodwaters. Insurance costs tend to be higher, and there are regulatory hurdles and permitting processes for floodplain construction.
- Environmental and Safety Considerations: Flood-prone sites require extra safety measures to prevent hazardous material release during floods, especially important for an aluminum recycling plant that may involve chemicals or heavy machinery.

Given these factors, it would be prudent only if the plant construction includes robust flood mitigation measures such as:

Elevated foundations well above the flood level

- Flood-resistant construction materials and design
- Engineering controls for runoff management and erosion control
- Comprehensive regulatory compliance
- Emergency planning for flood events

Without these, the risk of flood damage and operational disruption is high, making the site location less advisable. Consulting with hydrological and structural engineers for a detailed site-specific flood risk assessment and design adaptation would be a necessary step before proceeding.

In summary, building the plant there is potentially viable but only with sophisticated flood resilience design and mitigation. Otherwise, the risks posed by the valley's flooding and runoff characteristics would make it imprudent [1] [2].



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Does emissions aluminum recycling plants disbursement stack have heavier particulate that falls to the ground relatively close to the stack location

Yes, emissions from aluminum recycling plants' discharge stacks typically include particulate matter, which consists of dust, smoke, and metal particulates generated during melting and other processes. This particulate matter can be heavy enough that some of it tends to fall out of the air relatively close to the stack base before dispersing further.

Specifically, secondary aluminum production plants emit various particulate matter including alumina, metals, and other hazardous air pollutants from preprocessing and furnace operations. These particles vary in size, but larger or heavier particulates fall to the ground near the stack location, while finer ultrafine particles may disperse more broadly [1] [2] [3]. In general, emissions control devices aim to reduce particulate release, but some amount still settles relatively close to the stack due to gravity and particle weight [4].

In summary, aluminum recycling stack emissions include heavier particulates that do fall near the stack as well as finer particulates that disperse farther $\frac{[1]}{2}$ $\frac{[2]}{3}$.



Particulate near aluminum plants

Particulates near aluminum plants often include aluminum-containing dust and other industrial emissions. These particulates can settle on nearby surfaces such as cars, homes, and pools, raising health concerns among local residents due to possible exposure to metal particles and associated chemicals [5].

Aluminum particulates in the air come from industrial processes and often exist as oxides, silicates, and hydroxides. These particles may be heavier and settle near the plant or finer and dispersed over longer distances. Sources of aluminum particulates include dust from soil, emissions from smelting and recycling, and industrial activities processing crustal minerals [6].

Some health studies indicate exposure to certain particulates and gases from aluminum smelters can affect workers and communities, with dust concentrations sometimes reaching several mg/m³ in workplaces [7].

In summary, particulate matter near aluminum plants includes heavier aluminum dust that can settle close to the facility, as well as finer particles that can disperse further, potentially affecting

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- 2. https://airqoon.com/resources/aluminum-industry-and-environmental-impacts/
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- 6. https://www.atsdr.cdc.gov/toxprofiles/tp22-c6.pdf
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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:

$$Hq = H + 1.5L$$

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:

$$Hq = H + 1.5L$$

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:

$$Hg = 1,200\,ft + 1.5 imes 1,200\,ft = 1,200\,ft + 1,800\,ft = 3,000\,ft$$

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]

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:

- 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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How high will the emissions from an aluminum recycling plant go up into the atmosphere out of the disbursement stack if it is 100 ft tall and the climate is dry and warm

The height to which emissions from an aluminum recycling plant's stack will rise into the atmosphere depends on several factors, including the physical stack height, exit gas temperature, exit velocity, stack diameter, ambient wind speed, and atmospheric conditions such as temperature and stability.

For a 100-foot tall stack in a dry, warm climate, plume rise can significantly increase the effective height at which emissions are released. This effective height is the combination of the physical stack height plus the plume rise due to buoyancy and momentum of the hot exhaust gases.

Plume rise formulas, such as those developed by G.A. Briggs (1969), are commonly used to estimate this additional height. Key parameters include:

- Exit gas velocity and temperature (typically hotter than ambient air in a warm climate, causing buoyancy)
- Wind speed at stack height (typically moderate in warm climates)
- Stack diameter and exit conditions

In general, warm and dry conditions can enhance plume rise compared to cooler, more humid conditions because the buoyant hot gases rise more readily in warmer ambient air.

For a 100 ft (≈30 m) stack, typical plume rise from industrial stacks with moderate to high exit temperatures and velocities can add on the order of tens to over a hundred feet (meters) in effective stack height. For example, plume rise could add around 50 to 150 feet (15 to 45 meters) or more, depending on the exhaust heat and air velocity through the stack.

This means the emissions could be effectively dispersed at heights around 150 to 250 feet (45 to 75 meters) or higher above ground level in such a climate, promoting better dilution and dispersion of pollutants before they reach ground level.

Factors specific to aluminum recycling plants—such as large heat releases from scrap melting processes and dry scrubber stacks—may create plume merging and enhanced lift effects, contributing to higher plume rise beyond the physical stack height.

Overall, while the exact plume rise depends on specific operational parameters and local meteorology, a 100-foot stack in a dry, warm climate can be expected to have an effective emission release height on the order of 150 to 250 feet or more due to plume rise.

For precise assessment, detailed measurements or simulations using plume rise models including exhaust temperature, velocity, wind speed, and atmospheric stability are recommended. These models consider stack parameters and environmental conditions to calculate plume rise accurately for regulatory and environmental compliance purposes.



How high will the emissions from an aluminum recycling plant go up into the atmosphere out of the disbursement stack if it is 100 ft tall and the climate is cool and dry

In a cool and dry climate, the emissions from an aluminum recycling plant's 100-foot tall stack will have a different plume rise effect compared to a warm climate. Cooler ambient temperatures generally reduce the buoyancy of the hot exhaust gases, resulting in a smaller plume rise.

Plume rise depends on stack parameters such as exit gas temperature and velocity, wind speed, and atmospheric stability. In cool, dry climates:

- The temperature difference between stack gases and ambient air is larger, but the surrounding cooler air is denser, which tends to suppress the vertical rise somewhat.
- The dry atmosphere has little moisture to influence plume buoyancy through humidity effects.

Typically, the effective stack height (stack height + plume rise) in such climates may increase by a moderate amount, potentially on the order of 30 to 80 feet above the physical stack height for a 100 ft stack, depending on the exact parameters (gas exit velocity, temperature, and wind conditions).

Therefore, emissions would likely be dispersed effectively at heights around 130 to 180 feet or so above ground level.

To summarize:

- Physical stack height: 100 ft
- Approximate additional plume rise in cool, dry climate: 30 to 80 ft
- Effective emission release height: about 130 to 180 ft above ground

This smaller plume rise compared to warm climates is due to reduced buoyancy effects in cooler ambient air. Accurate determination requires specific operational and meteorological data and detailed plume rise modeling.

If you need more precise data or modeling advice, I can guide you on how to perform that calculation.