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## pH 11.3 Enhances the Solubility of Potassium Silicate for Liquid Fertilizer

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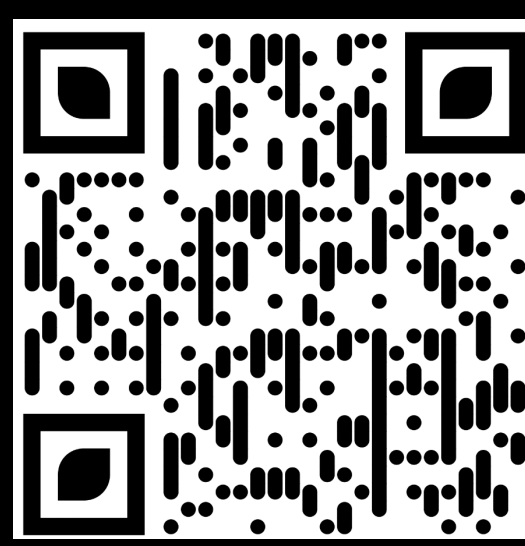




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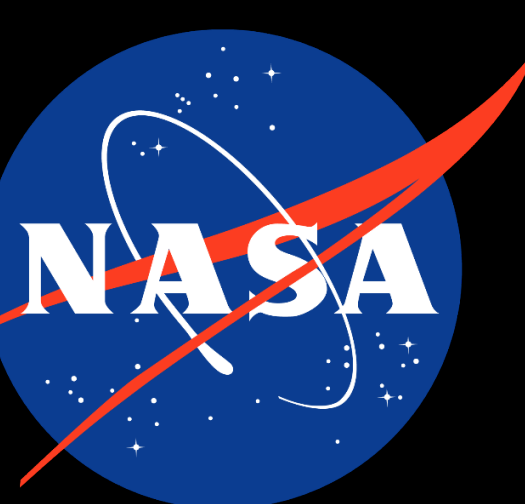


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# pH 11.3 Enhances the Solubility of Potassium Silicate for Liquid Fertilizer



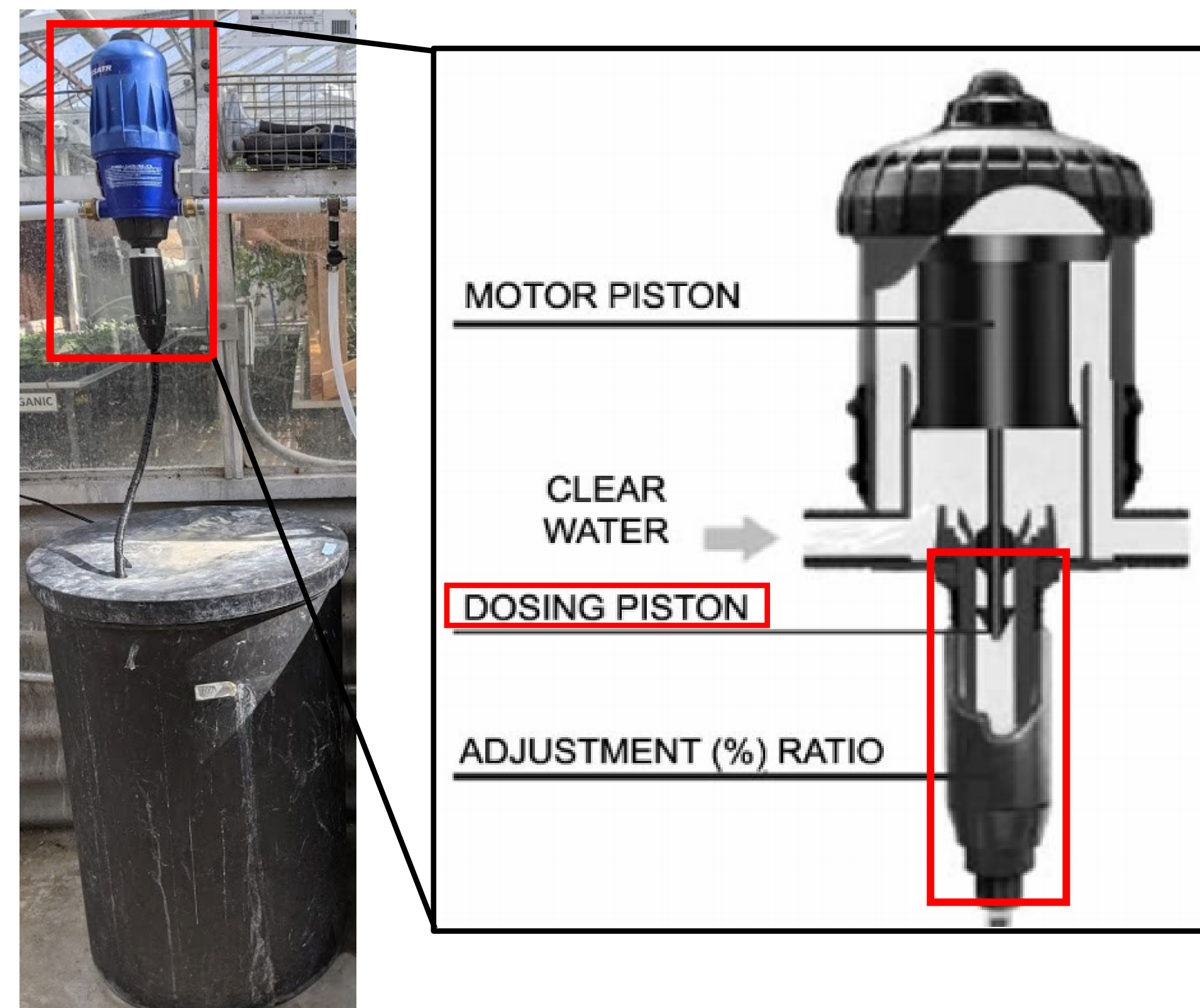
Funded by NASA:  
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## Background

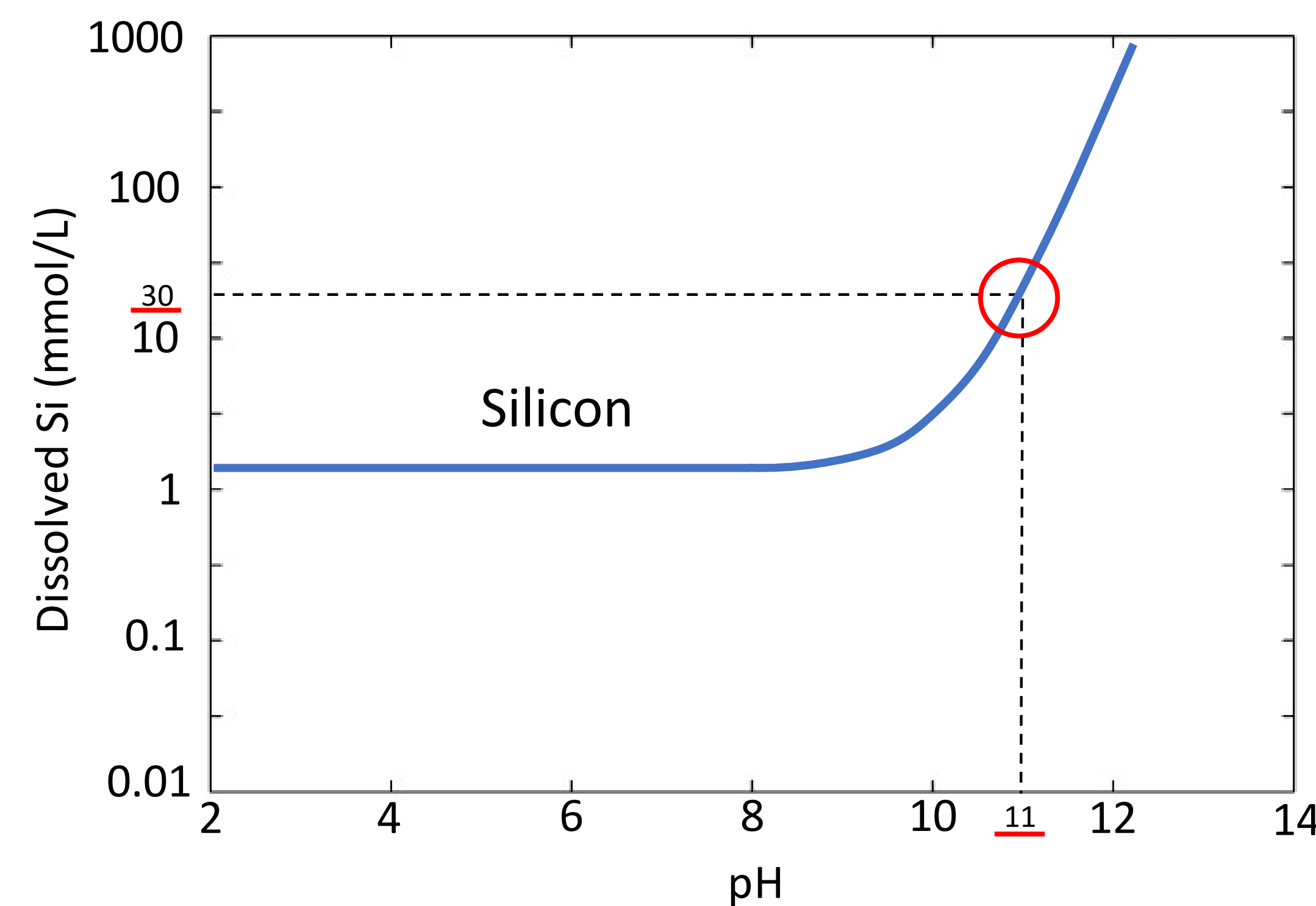
- Consistent delivery of silicon (Si) to the root-zone is beneficial.
- Potassium silicate-derived supplements (AgSil or K-Silicate) are commonly used to provide consistent, soluble silicon through a separate proportioning pump.

## The Problem

- The maximum solubility of silicon is only 1.7 mM below pH 8.
- Precipitation** in concentrated stock solutions causes **abrasion** and **premature failure** in dosing pistons. This results in excessive noise, inaccurate dosing, and the need for frequent replacement of seals.

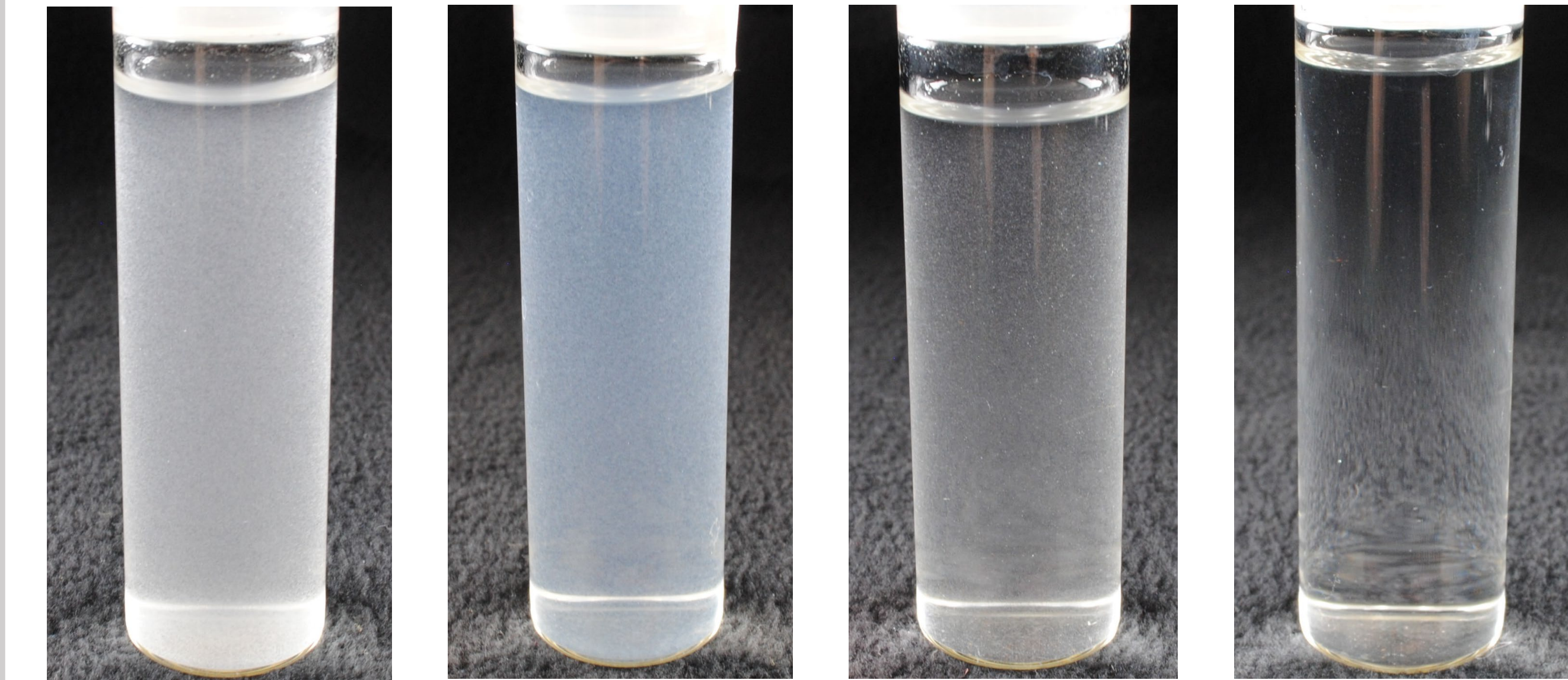


## Solubility of Si increases at high pH



To achieve a target concentration of 0.6 mM Si in final solution, a 30 mM concentrate in the stock tank (3.4 g AgSil/Liter) is required when using a 1:50 dilution. To achieve an optically clear stock solution, it is necessary to raise solution pH to at least 11.3.

## Calcium and pH affect turbidity of potassium silicate solutions

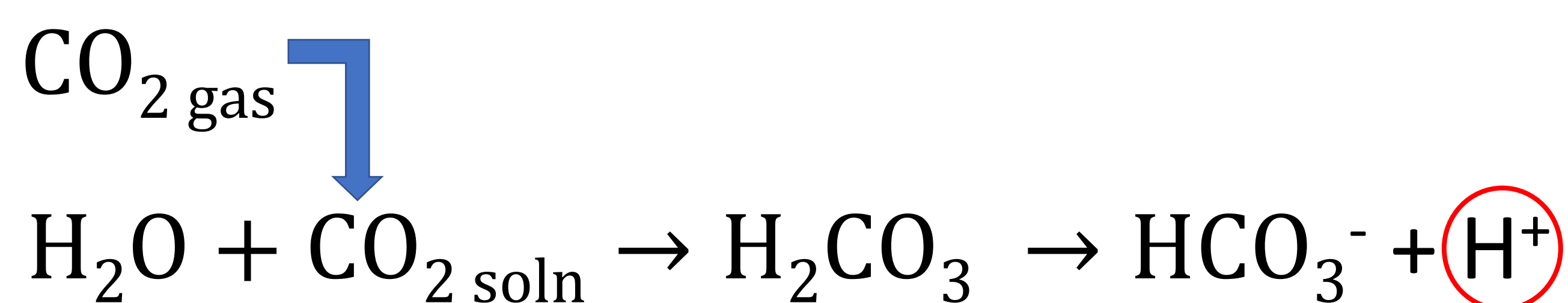
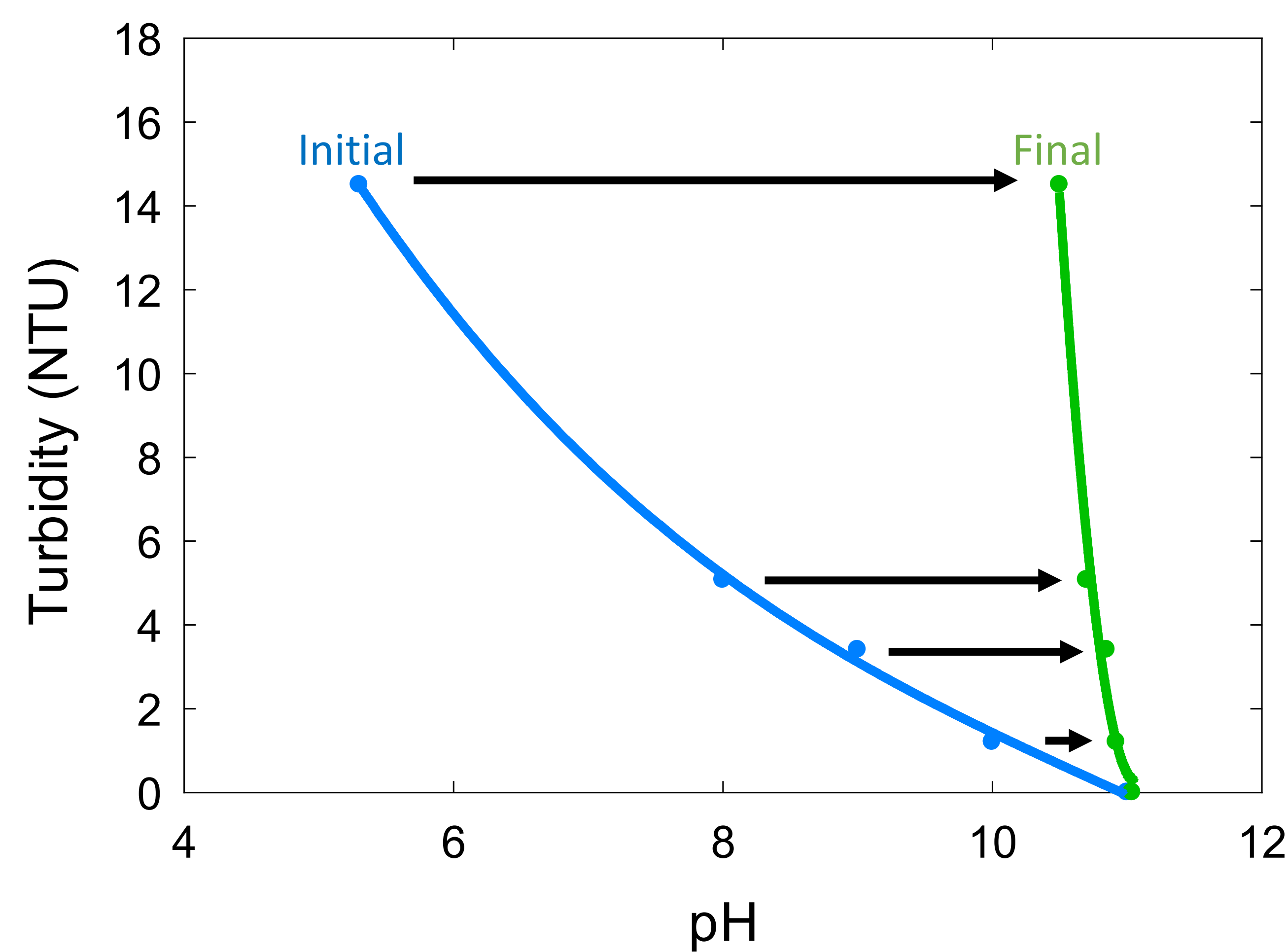


Tap water without pH adjustment (35+ NTU)    Tap water with pH adjustment (35+ NTU)    D.I. water without pH adjustment (14.5 NTU)    D.I. water with pH adjustment (0 NTU/clear)

AgSil solutions (30 mM) with deionized (D.I.) or tap water without pH adjustment and with pH adjustment to 8, 9, 10, and 11 using KOH before adding potassium silicate supplement. Both KOH and NaOH are effective bases for pH adjustment.

## Effect of pH on turbidity

- Concentrated solutions (30 mM) of Agsil and K-Silicate were made with pH-adjusted D.I. water. Optical clarity was measured using a turbidity meter.
- The experiment was repeated with tap water from Logan, UT (50 ppm Ca<sup>2+</sup>) (adjusted to pH 11.3). Significant precipitation was observed (35+ Nephelometric Turbidity Units, NTU).
- A CaCl<sub>2</sub> solution was made with deionized water to approximate the 50 ppm Ca<sup>2+</sup> content of Logan, UT tap water. This solution was then adjusted to pH 11 with KOH. The same precipitation was observed (35+ NTU) when AgSil was introduced. Silica readily complexes with calcium to form calcium silicate, which is minimally soluble.
- Long term stability of concentrated solutions can be extended by isolating them from atmospheric CO<sub>2</sub>, which acidifies the solution through formation of carbonic acid (carbonate).



## Conclusions

- Increasing pH to 11.3** by adding 0.3 g KOH or 0.2 NaOH per liter deionized water **prior** to adding AgSil is necessary to achieve optical clarity.
- Covering stock solutions** is necessary to maintain alkaline pH.
- Adding 0.6 mM Si increased the pH of the final irrigation solution by 0.25 pH units.
- KOH contributes 5.3 mM K<sup>+</sup> to the final solution.
- This approach has achieved consistent dosing and maintained intact seals in proportioning pumps.**

