Leachate is runoff water from a landfill. It contains a number of compounds from the waste it encounters.

The current process utilizes a bioreactor to remove organic compounds from the leachate stream.

The leachate can then be sent to normal wastewater treatment.

The amount of lime required, 1063 kg/day, was calculated based on 3 years of leachate composition data.

The process will remove the calcium carbonate according to: \[
\text{Ca(HCO}_3\text{)}_2 + \text{Ca(OH)}_2 \rightarrow 2\text{CaCO}_3 + 2\text{H}_2\text{O}
\]

The lime will be stored in a storage silo and fed into the bioreactor which provides surface area for the bacteria to grow.

The final solution was a chemical treatment system using hydrated lime to cause the calcium carbonate to precipitate out of the leachate. This would then be removed via a clarifier.

The lime reacts with the calcium carbonate according to: \[
\text{Ca(HCO}_3\text{)}_2 + \text{Ca(OH)}_2 \rightarrow 2\text{CaCO}_3 + 2\text{H}_2\text{O}
\]

The process which involves the adjustment of pH to fall within the limits of the bioreactor. This is done by adding carbon dioxide directly into the solution. The chemical would react with the calcium carbonate to form a solid precipitate. This precipitate would then be separated out. This was the solution decided upon.

Overall, the task was to design a system which would remove the calcium carbonate before it could cause issues. The following were considered.

- **Ion Exchanger:** Comprised of a tank filled with resin beads coated with sodium ions (Na\(^+\)). Calcium carbonate and other metals in solution would be exchanged for the sodium ions. This solution was decided against due to cost considerations.

- **Electrochemical Precipitation:** An anode and a cathode would be placed within the solution to force oxidation reactions to occur. This would cause the carbonates to react and precipitate out of solution. It was decided against due to lack of engineering maturity.

- **Chemical Treatment:** Lime (CaOH\(_2\)) or sodium hydroxide (NaOH) would be added to the leachate stream. The chemical would react with the calcium carbonate to form a solid precipitate. This precipitate would then be separated out. This was the solution decided upon.

**Capital Costs:**
- Line Silo: 60,000
- Coagulation and Flocculation: 45,000
- Clarifier: 13,000
- Recarbonation: 12,000
- Total: 130,000

**Operational Costs:**
- Line Silo: 49,000
- Coagulation and Flocculation: 31,000
- Clarifier: 3,000
- Recarbonation: 27,500
- Total: 108,500

**Conclusions**
- The final solution is a lime treatment system. It will include a lime silo for chemical storage, coagulation and flocculation tanks for mixing, a clarifier for separation, and recarbonation for pH adjustment.
- The total capital cost is $250,800.
- The total annual operating cost is $108,100.
- The process will remove the calcium carbonate from the leachate and prevent further scaling.

**Figure 1:** Flow diagram of the leachate treatment system currently in place.

**Figure 2:** New reactor media of similar shape and material.

**Figure 3:** Scale coated reactor media.

**Figure 4:** A process flow diagram of the proposed process.

**Figure 5:** Calculated lime requirement for each month over the past 3 years.

**Figure 6:** Silo capacity versus cost over various time periods.

**Figure 7:** Lime handling schematic.

**Figure 8:** Diagram of the screw conveyor.

**Figure 9:** Schematic of the coagulation and flocculation tanks.

**Figure 10:** Diagram of the plate settler clarifier.

**Figure 11:** Illustration of the recarbonation process.