

```
.label-body { display: inline-block; margin-left: .5rem; font-weight: normal; } ul { list-style: circle; } ol { list-style: decimal; } ul ul, ul ol, ol ol, ol ul {
margin: 1.5rem 0 1.5rem 3rem; font-size: 90%; } li > p {margin : 0;} th, td { padding: 12px 15px; text-align: left; border-bottom: 1px solid #E1E1E1;
} th:first-child, td:first-child { padding-left: 0; } th:last-child, td:last-child { padding-right: 0; } button, .button { margin-bottom: 1rem; } input,
textarea, select, fieldset { margin-bottom: 1.5rem; } pre, blockquote, dl, figure, table, p, ul, ol, form { margin-bottom: 1.0rem; } .u-full-width { width:
100%; box-sizing: border-box; } .u-max-full-width { max-width: 100%; box-sizing: border-box; } .u-pull-right { float: right; } .u-pull-left { float: left;
} hr { margin-top: 3rem; margin-bottom: 3.5rem; border-width: 0; border-top: 1px solid #E1E1E1; } .container:after, .row:after, .u-cf { content: "";
display: table; clear: both; } pre { display: block; padding: 9.5px; margin: 0 0 10px; font-size: 13px; line-height: 1.42857143; word-break: break-all;
word-wrap: break-word; border: 1px solid #ccc; border-radius: 4px; } pre.hljl { margin: 0 0 10px; display: block; background: #f5f5f5; border-radius:
4px; padding : 5px; } pre.output { background: #ffffff; } pre.code { background: #ffffff; } pre.julia-error { color : red } code, kbd, pre, samp { font-
family: Menlo, Monaco, Consolas, "Courier New", monospace; font-size: 0.9em; } @media (min-width: 400px) {} @media (min-width: 550px) {}
@media (min-width: 750px) {} @media (min-width: 1000px) {} @media (min-width: 1200px) {} h1.title {margin-top : 20px} img {max-width :
100%} div.title {text-align: center;} >
```

# BEE 4750/5750 Homework 1

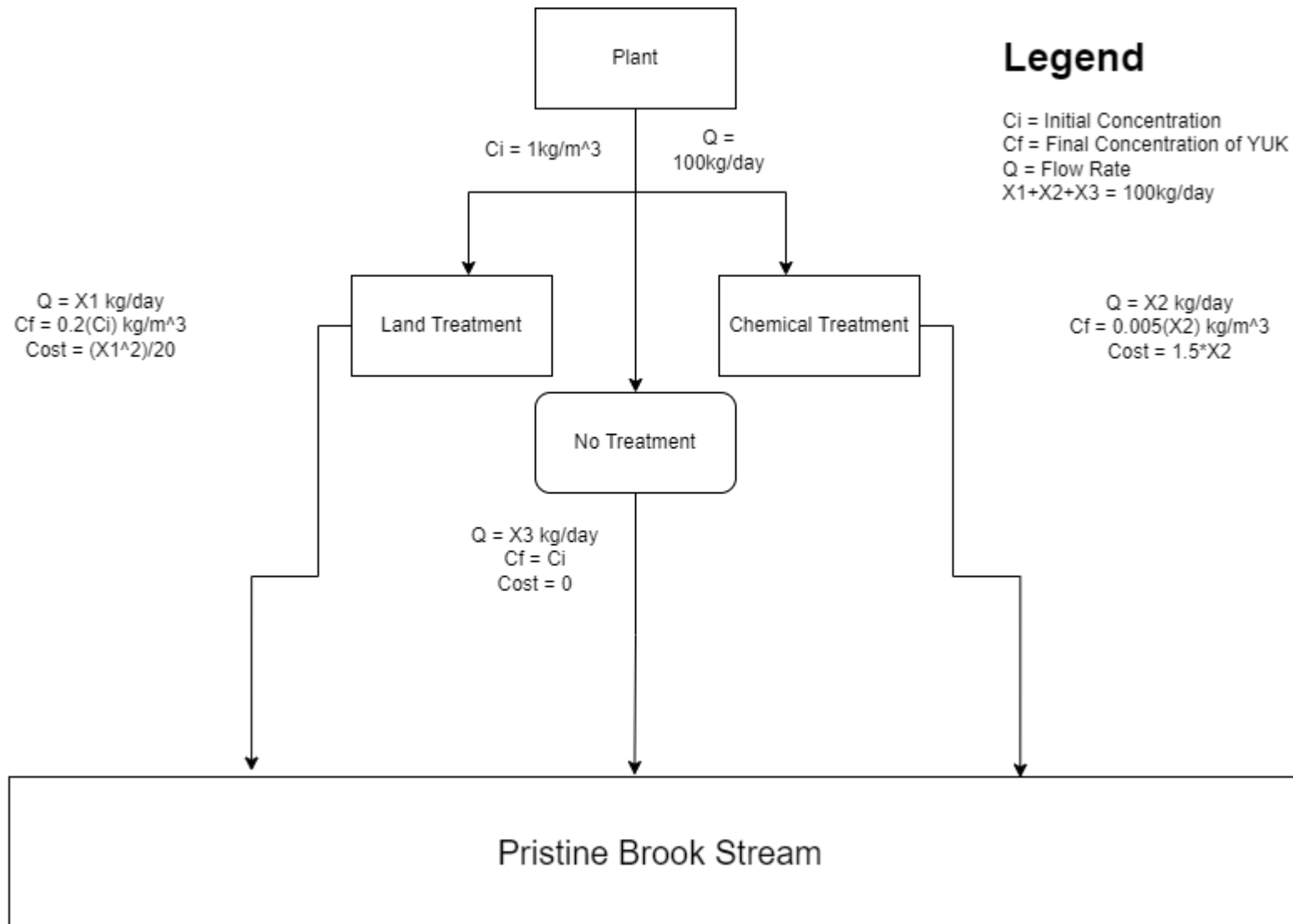
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**2022-09-14**

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## Problem 1

### Problem 1.1



## Problem 1.2

There are many possible methods for treating the  $100 \frac{kg}{day}$

of wastewater released by the plant.

Creating a model for this scenario would involve a model that took into account a combination of the three different treatment paths.

First, one would have to take into the account the constraint indicated by the diagram:

$$X_1 + X_2 + X_3 = 100$$

which is the conservation of mass between all three treatment methods.

This concept can be extended to the YUK concentration after each method as well. 0

$$(C_{i,1} * X_1) + (C_{i,2} * X_2) + (C_{i,3} * X_3) = C_f$$

As an example, a treatment plan using solely land treatment would have a final concentration:

$$C_f = C_{i,1} * X_1$$

with  $X_1 = 100 \frac{kg}{day}$ .

The cost would be computed similarly using the equations in the diagram.

## Problem 1.3

```
julia> function model(x1,x2,x3)
    #Function that computes the final YUK concentration given the following input variables:
    #=
    x1 = wastewater allocated to land treatment
    x2 = wasteater allocated to chemical treatment
    x3 = wastewawter allocated to no treatment
    x1+x2+x3 must sum to 100
    =#
```

```
c1 = x1*0.2
c2 = x2*0.005
c3 = x3
cf = c1 + c2 + c3

cost = ((x1^2)/20) + (1.5*x2)
return cost, cf
```

```
end
```

```
model (generic function with 1 method)
```

## Problem 1.4

```
julia> using Distributions
```

```
julia> using Plots
```

```
julia> #X = cost, y = concentration
```

```
x = []
```

```
Any[]
```

```
julia> y = []
```

```
Any[]
```

```
julia> for k in 1:100
```

```
    whocares = rand(Dirichlet(3,1)) * 100
```

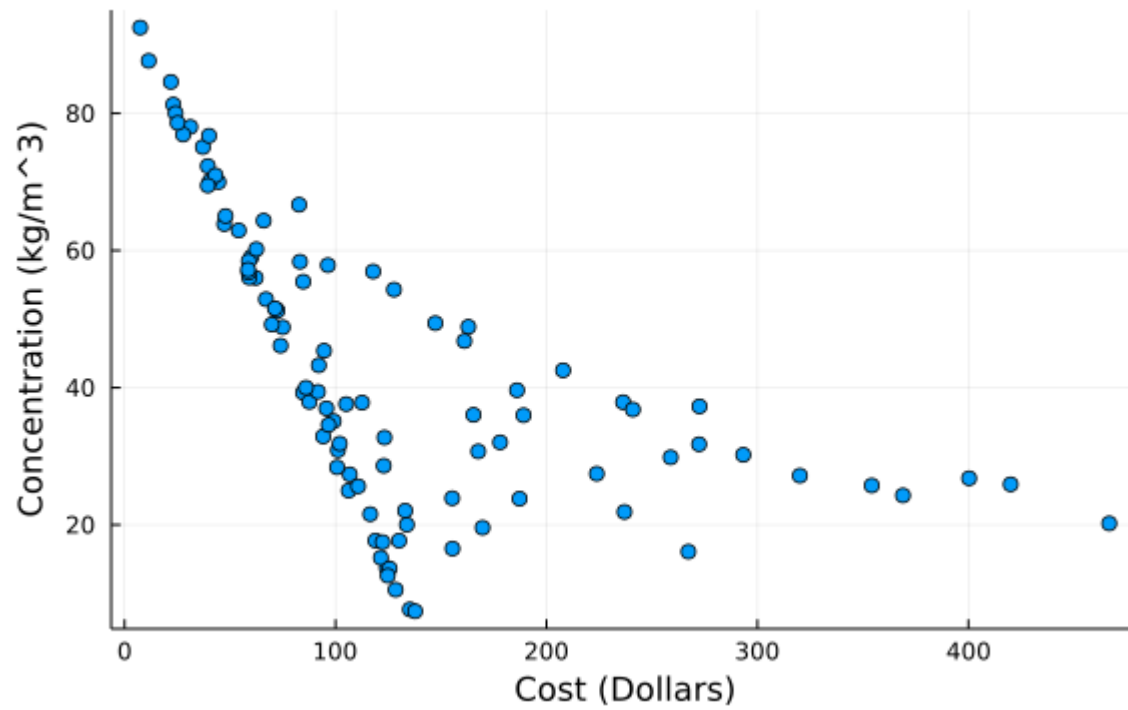
```
    cost_val, conc = model(whocares[1],whocares[2],whocares[3])
```

```
    append!(x,cost_val); append!(y,conc)
```

```
end
```

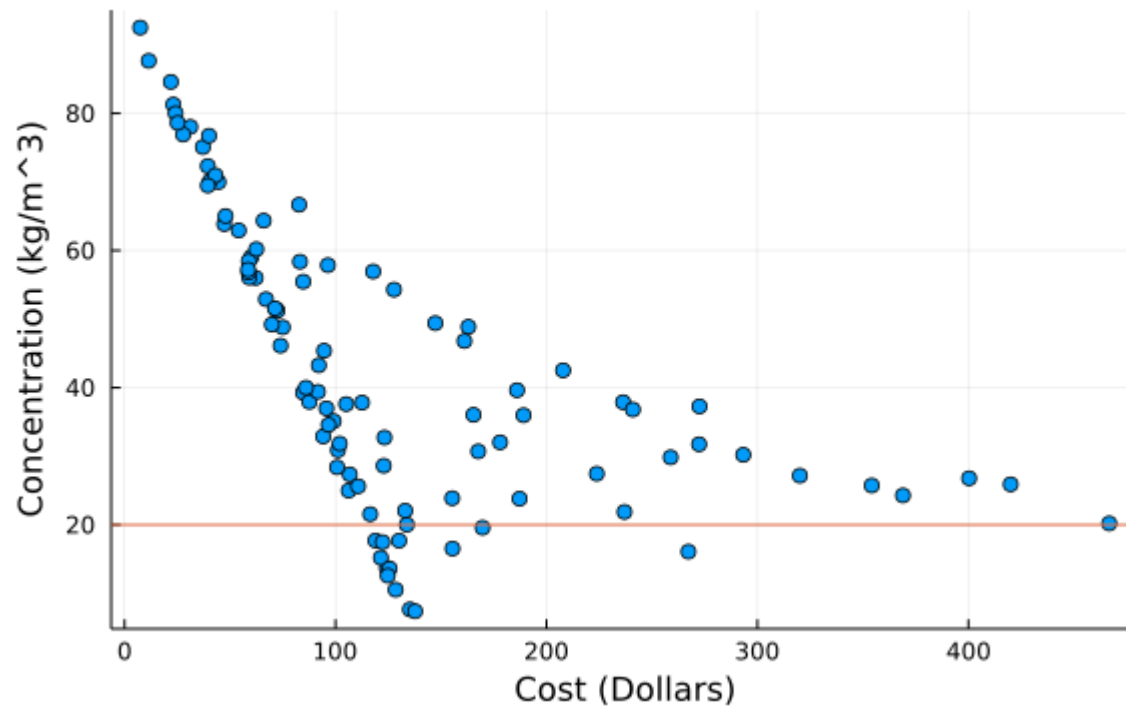
```
julia> scatter(x,y,legend=false,xlabel="Cost (Dollars)" ,ylabel="Concentration (kg/m^3)",plot_title="Concentration vs. Cost" )
```

## Concentration vs. Cost



```
julia> hline!([20])
```

## Concentration vs. Cost



From the plot above we can see that the cost for treatment that meets the standard (under  $20 \frac{kg}{m^3}$ ) is generally at least 100 dollars.

### Problem 1.5

I would select a treatment plan that meets the criteria while minimizing the cost. This would mean I would be looking for points below the horizontal line and as far to the left as possible. This plan could reflect the interest of different parties because of the fact that it includes both cost and YUK concentration. Factory owners may want to maximize profit and look forward to barely meeting the treatment standards if it means a lower price. On the other hand, environmental and public agencies may be fine with not optimizing price in favor of lowering pollution concentration as much as possible. The plot in problem 1.4 presents both of these scenarios, as well as ones where they overlap.

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The design from problem 1.4 sought to use a variety of combinations. However, this is restricted because it only has 100 data points. A design model that uses preset combinations of  $x_1$ ,  $x_2$ , and  $x_3$  would also be restricted, but its data points would be static and allow for consistent analysis. Overall, I think that the numerical setup from the previous problem allowed me to properly analyze the correlation between cost and concentration so that a reasonable decision could be made. A different experimental design may have changed the outcome only slightly since the values for how much flow is going into each treatment plant was effectively selected at random with certain constraints.

## Problem 1.6

The model can be improved by adding more detail. One example of this could be investigating the YUK pollutants reactions in the environment. Perhaps the YUK compound has a decay rate that makes method 3 (no treatment) more viable than it really seems. One assumption was that the system was closed. It is possible that some of the wastewater is lost to the environment, altering the volume of flow and concentration of YUK that ultimately ends up in the stream. These results only apply to a perfectly closed system without reaction of YUK in the environment.

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# References

Stackoverflow and juliadiscourse forums

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