Heap Leach Draindown Estimator HLDE

By

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HEAP LEACH DRAINDOWN ESTIMATOR (HLDE)

- Excel workbook developed for estimation of the heap leach pad draindown curve
  - Developed by JBR Environmental Consultants, Inc. and Newmont Mining Corporation
  - Calculates flow rates for active and historically leached portions of the heap over time
  - Uses principles similar to those found in complicated unsaturated flow models
  - Used to calculate time frames for process fluid stabilization (PFS) in bond cost estimates

HLDE

- Tool to help estimate Process Fluid Stabilization (PFS) reclamation bond costs
  - Intended for use in calculating PFS bond costs for new projects or projects without a Final Permanent Closure Plan (FPCP)
  - More comparisons of HLDE to actual draindown curves is required for HLDE to be used for FPCP
  - Simplifies modeling for heap leach draindown while still obtaining results sufficient for bonding purposes
  - Estimates time frames needed for recirculation and active evaporation during PFS

HLDE

- Determines time frame for PFS activities (Phases I-IV)
  - Recirculation time needed (Phase I)
  - Active evaporation time needed (Phase I & II)
  - E/ET Cell construction period (Phase III)
  - Time to reach passive evaporation (Phase IV)
  - Labor, Equipment, Power and Material costs can then be estimated for each Phase

Why?

- Industry shouldn't need to spend $100,000 on draindown modeling for heap leach pads for bonding purposes
- There should be a method to simplify the modeling while still obtaining results that are sufficient for bonding purposes

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Requirements for Model

- Hydrogeologic model to represent unsaturated zone flow
- Data needs to be readily available from the mines
- Complex enough to accurately represent hydrogeologic conditions at site
- Not so complex that a degree in hydrogeology is required to use it

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HLDE

- Uses Brooks and Corey Equation to simulate draindown
- Includes recirculation, active (forced) and passive evaporation
- Considers monthly meteorological data (precipitation and evaporation)
- Incorporates process ponds that will be converted to ET or E cells

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Hydrogeologic Equation

- Brooks and Corey (1966) as referenced in Tindall & Kunkel (1999)

$$K(\theta) = K_S \left(\frac{\theta - \theta_r}{\phi - \theta_r} \right)^{\gamma}$$

Where
θ is the volumetric moisture content
Ks is the saturated hydraulic conductivity
θr is the residual moisture content
Φ is the porosity
γ is an empirical parameter related to grain size distribution

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How to get HLDE inputs

- Existing site specific data is the best
- How to estimate inputs if not currently available
  - Column tests (Ksat, θsat, θr)
  - Field measurements (drilling and testing on heap)
  - Draindown tests
- Gamma (γ) can be calibrated in HLDE once other parameters are known

Inputs – Hydrogeologic and Operational

Total Area of Heap Leach Pad	ft2	9,975,240
	acres	229
Area of Actively Used Heap Leach Pad	ft2	800,000
Area of Historically Used Heap Leach Pad	ft2	9,175,240
Operational Draindown Rate	gpm	4,000
Application Rate	gpm/ft2	0.005
Height of Heap Leach Pad	ft	250
Saturated Hydraulic Conductivity (Ks)	ft/day	100
Residual Water Content (θr)	Decimal	0.1
θs (saturated moisture content)	Decimal	0.25
θapp (active application moisture content)	Decimal	0.23
θhist (moisture content of historic part at PFS start)	Decimal	0.17
γ (empirical drainage parameter)	unitless	28
Time unit of interest		Days

Input cells are green

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Inputs – Meteorological

Precipitation			
Total Annual Precip	13.27	inches	
Infiltration Rate	0.04		
Monthly Portion			
	%	inches/mo.	inches/day
January	11%	1.49	0.05
February	9%	1.21	0.04
March	10%	1.35	0.04
April	9%	1.22	0.04
May	10%	1.33	0.04
June	6%	0.83	0.03
July	4%	0.50	0.02
August	5%	0.65	0.02
September	6%	0.77	0.03
October	8%	1.01	0.03
November	11%	1.43	0.05
December	11%	1.46	0.05
Total (must equal 100%)	100%	13.25	

Monthly Pan Evaporation Data		
	inches/mo.	inches/day
January	0	0.00
February	0	0.00
March	0	0.00
April	5.1	0.17
May	7.09	0.23
June	8.9	0.30
July	10.54	0.34
August	9.37	0.30
September	6.51	0.22
October	3.95	0.13
November	0	0.00
December	0	0.00
Total	51.46	

Input cells are green

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Inputs – Active Evaporation

Evaporators		
Number of Evaporators on Day One	6	
Evaporator Pumping Capacity	100	gpm
Evaporator Operating Time	12	hr/day
	Efficiency	Effective Evaporation
	%	ft3/day
January	20%	11,551
February	20%	11,551
March	20%	11,551
April	40%	23,102
May	50%	28,877
June	60%	34,652
July	70%	40,428
August	80%	46,203
September	60%	34,652
October	40%	23,102
November	20%	11,551
December	20%	11,551
Averages	42%	17,807

Input cells are green

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Inputs – Recirculation

Recirculators		
Pump Capacity	4,000	gpm
	770,053	ft3/day
Pond Volume that Triggers Recirculation	7,505,000	gal
	1,003,342	ft3

Input cells are green

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Inputs – Pond/ET Cell Data

Pond Capacity Data		
Pond Capacity Data[2]	30,020,000	gal
	4,013,369	ft3
Beginning Pond Level	30,020,000	gal
	4,013,369	ft3

ET Cell Data		
Total Existing ET Cell Area[2]	267,588	ft^2
	6.14	ac
Total Flow Capacity of ET Cell	2.50	gpm/ac
	15.36	gpm

Input cells are green

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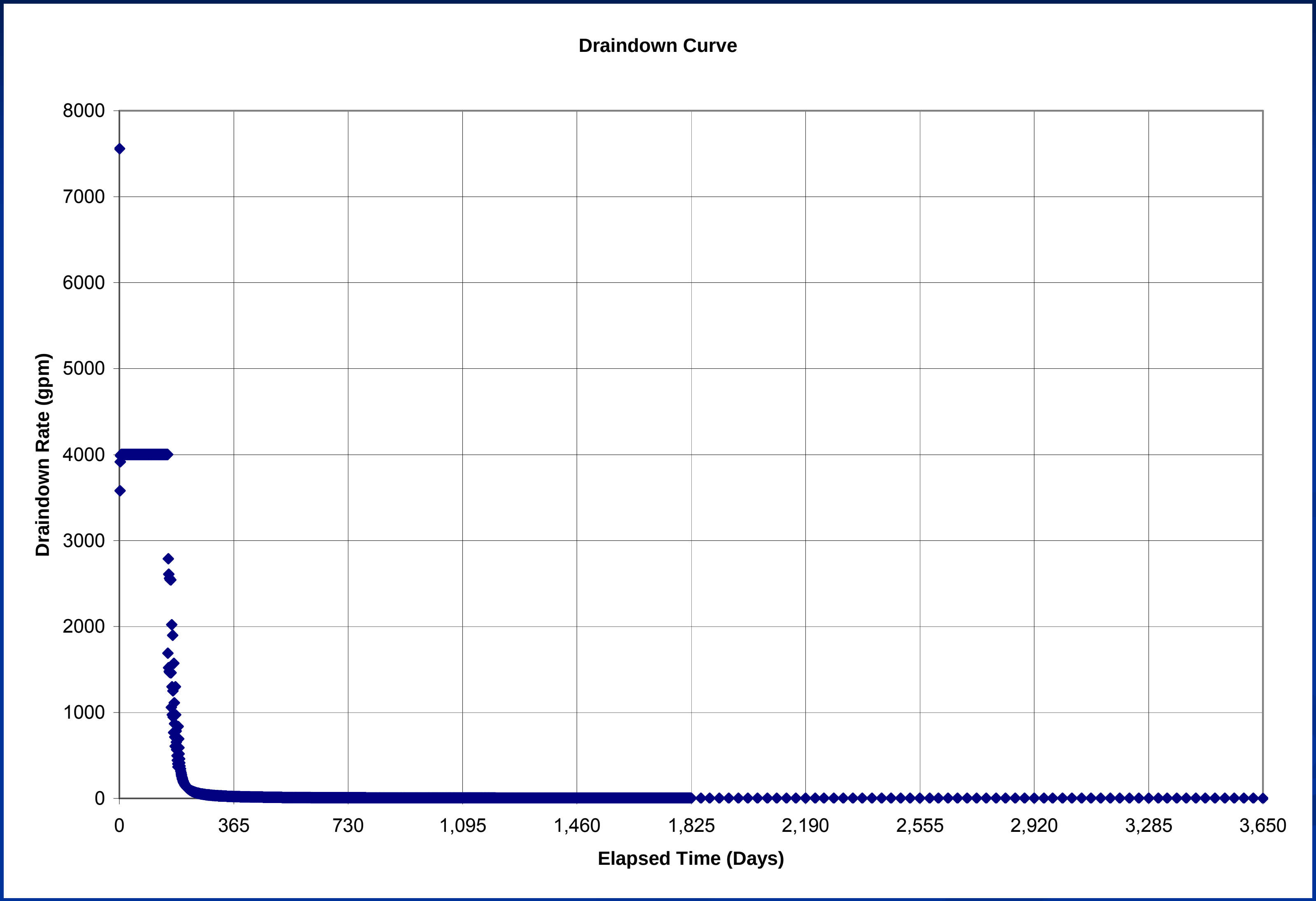
Results

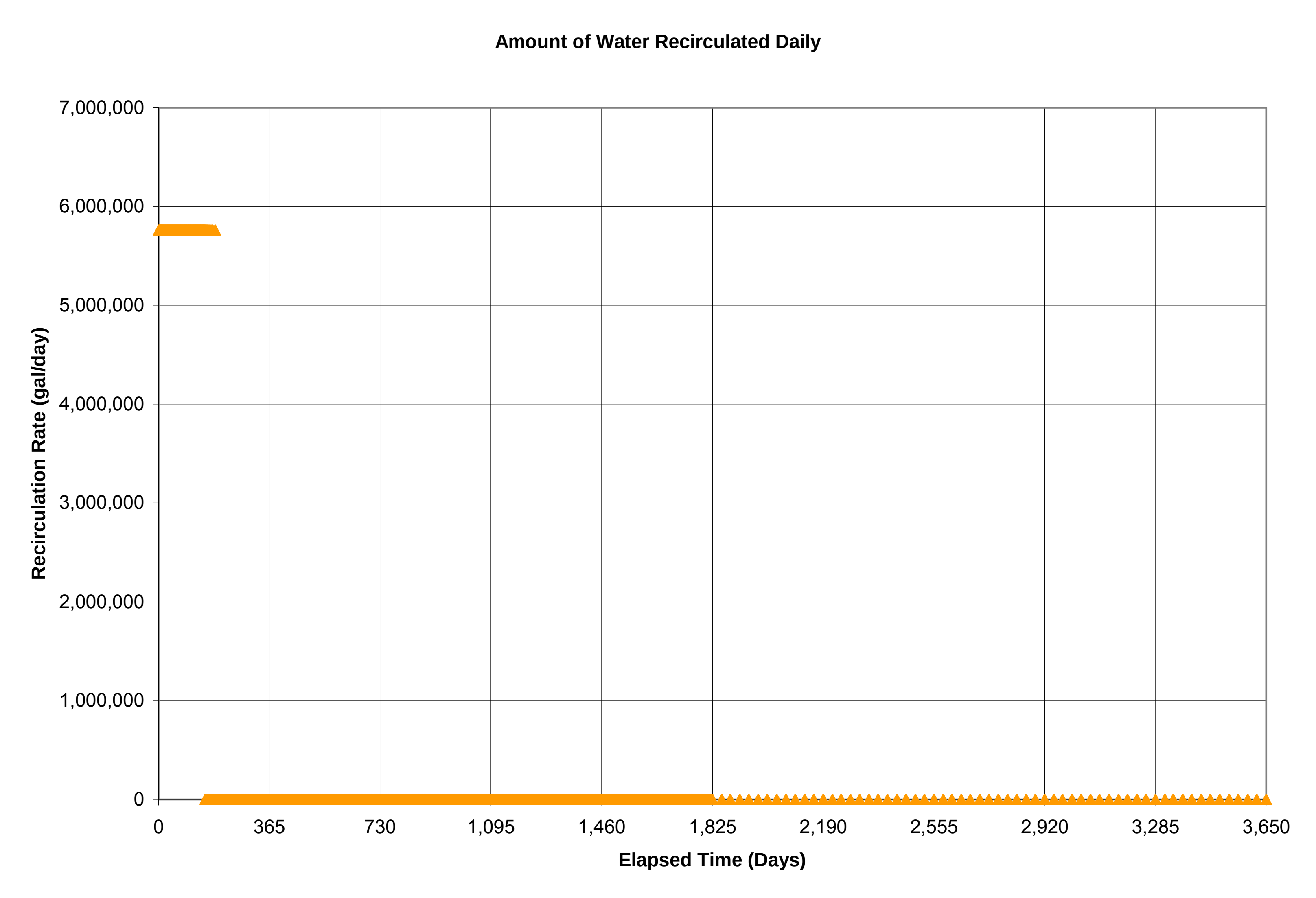
- Draindown Curve
- Examine 'Calcs Active' worksheet and curves to determine timeframes
  - Recirculation Timeframe
  - Active Evaporation Timeframe
- Evaluate totals
  - Total recirculated
  - Total actively evaporated

Results



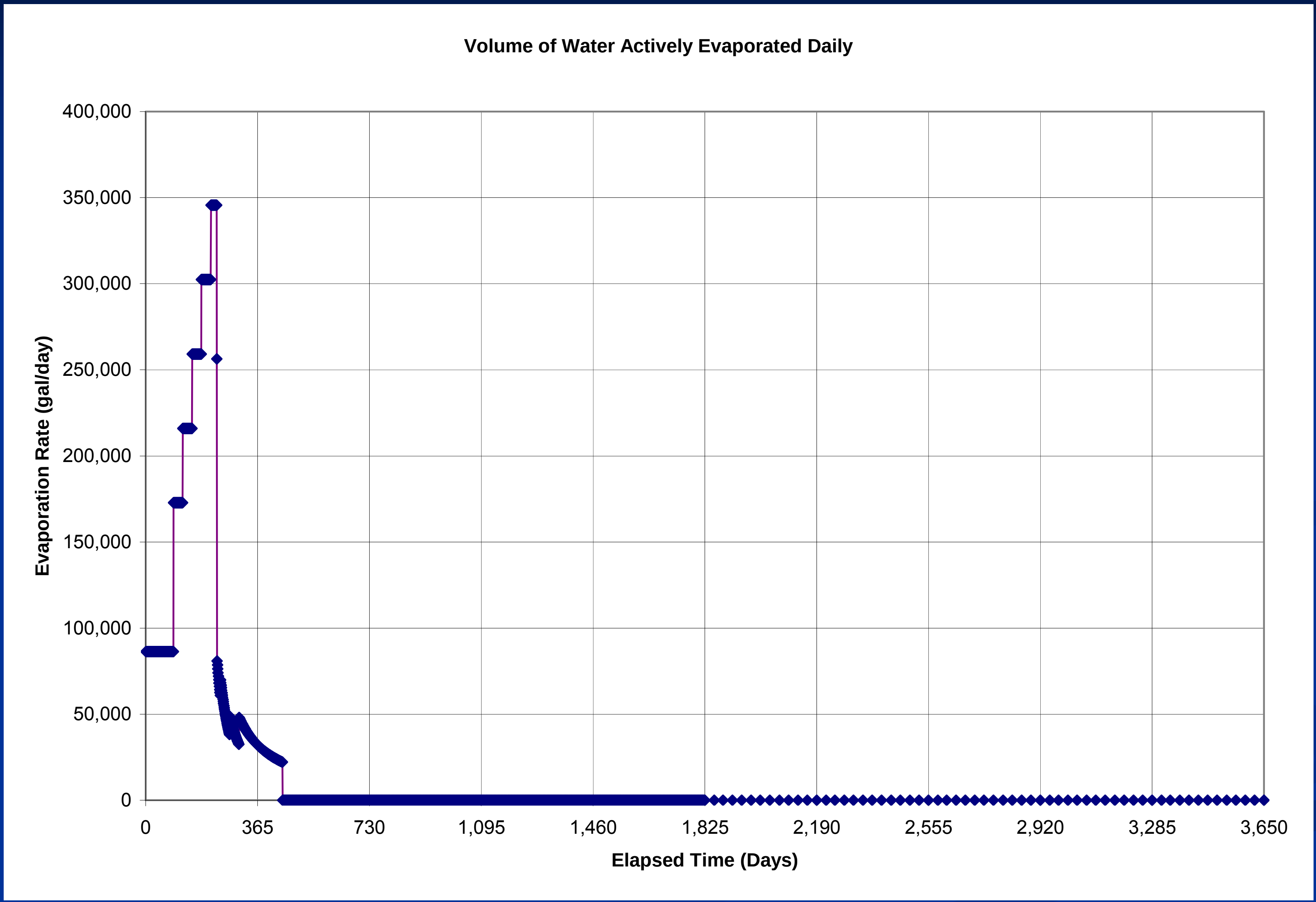
Draindown Curve – Shows how draindown decreases over time

Results



Recirculation Curve – Shows how much water is recirculated over time and how long water is recirculated

Results



Evaporation Curve – Shows how much water is actively evaporated over time and how long active evaporation will be required

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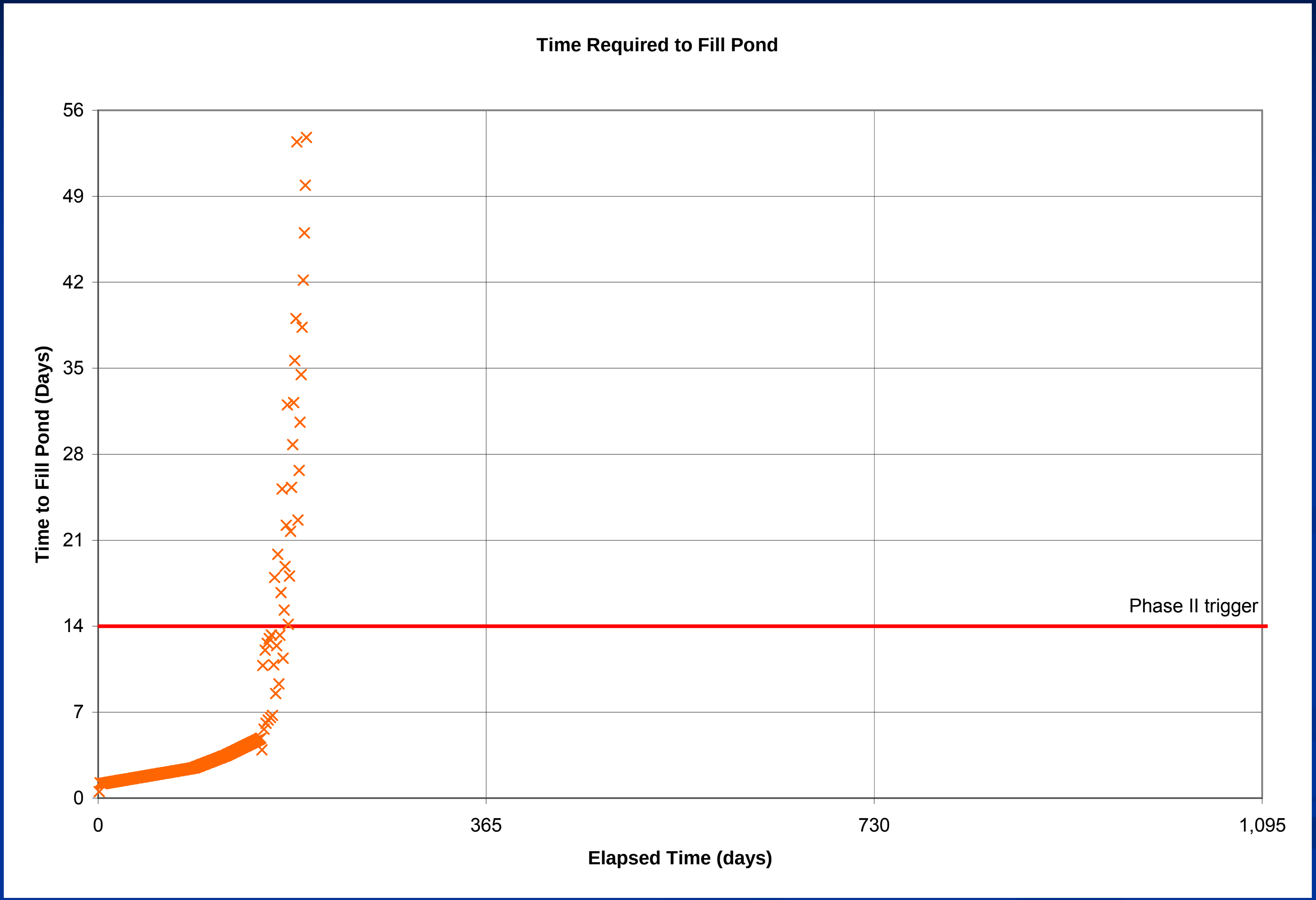
Results



Pond Fill Curve – Shows how long it takes at each time step for the ponds to fill
This is used to determine the length of the phases for costing purposes

Reclamation Costs

- Use HLDE results to determine costs
- Use NDEP's PFS Guidelines
  - Phases
  - Labor and equipment coverages

Any Questions?

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