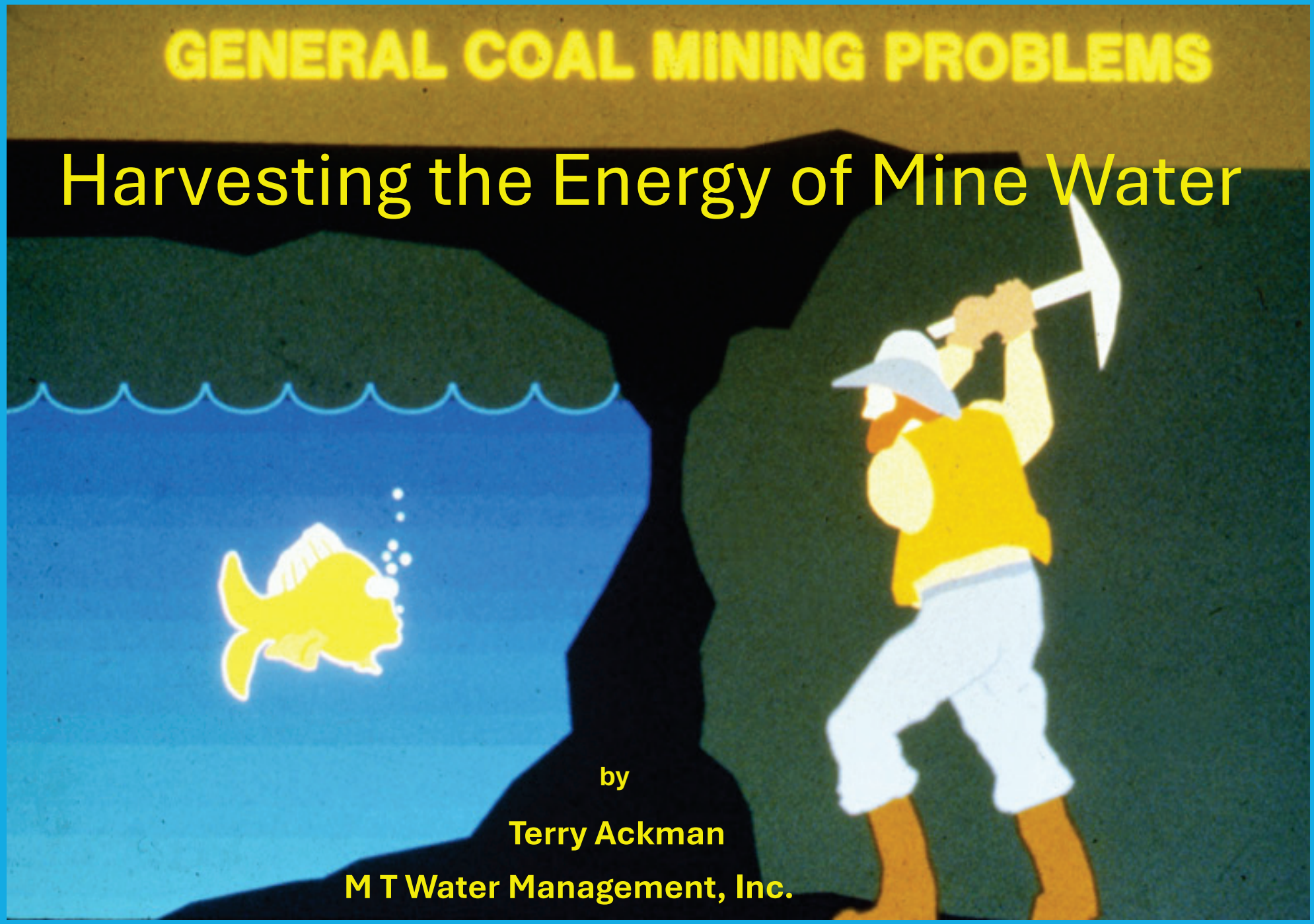
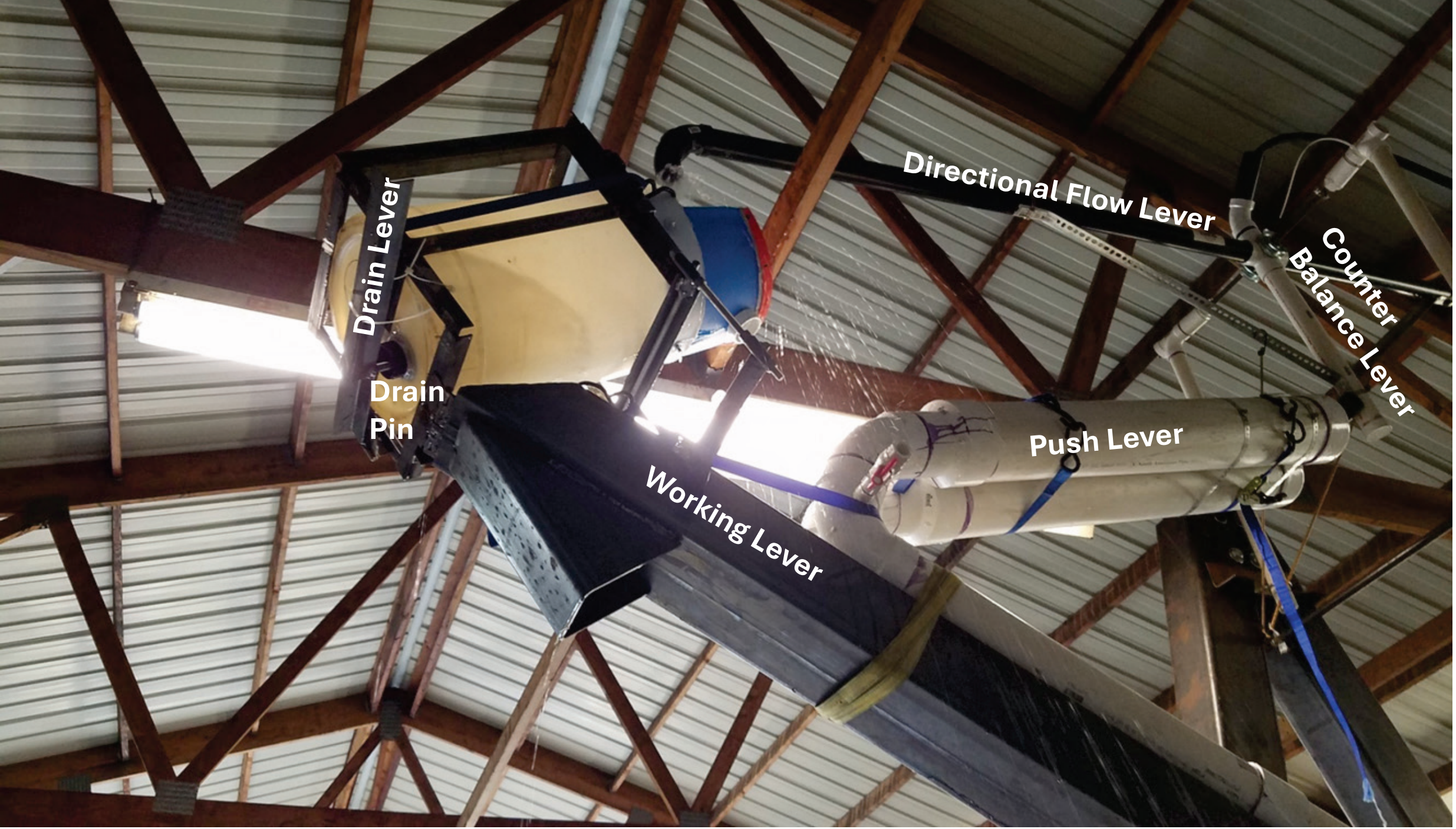


Harvesting the Energy of Mine Water

by

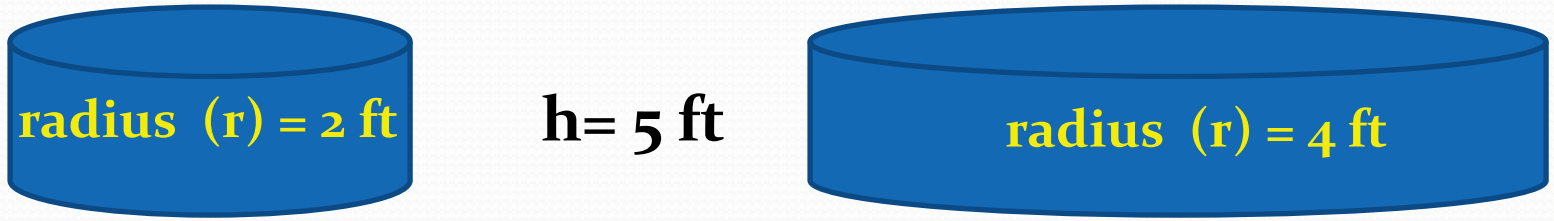
Terry Ackman

M T Water Management, Inc.


Drain Lever
Directional Flow Lever
Counter Balance Lever
Drain Pin
Push Lever
Working Lever

Basic Geometry

Volume = $\pi r^2 \times h$



Volume = 62.8 ft^3

Weight = 3,917 lbs

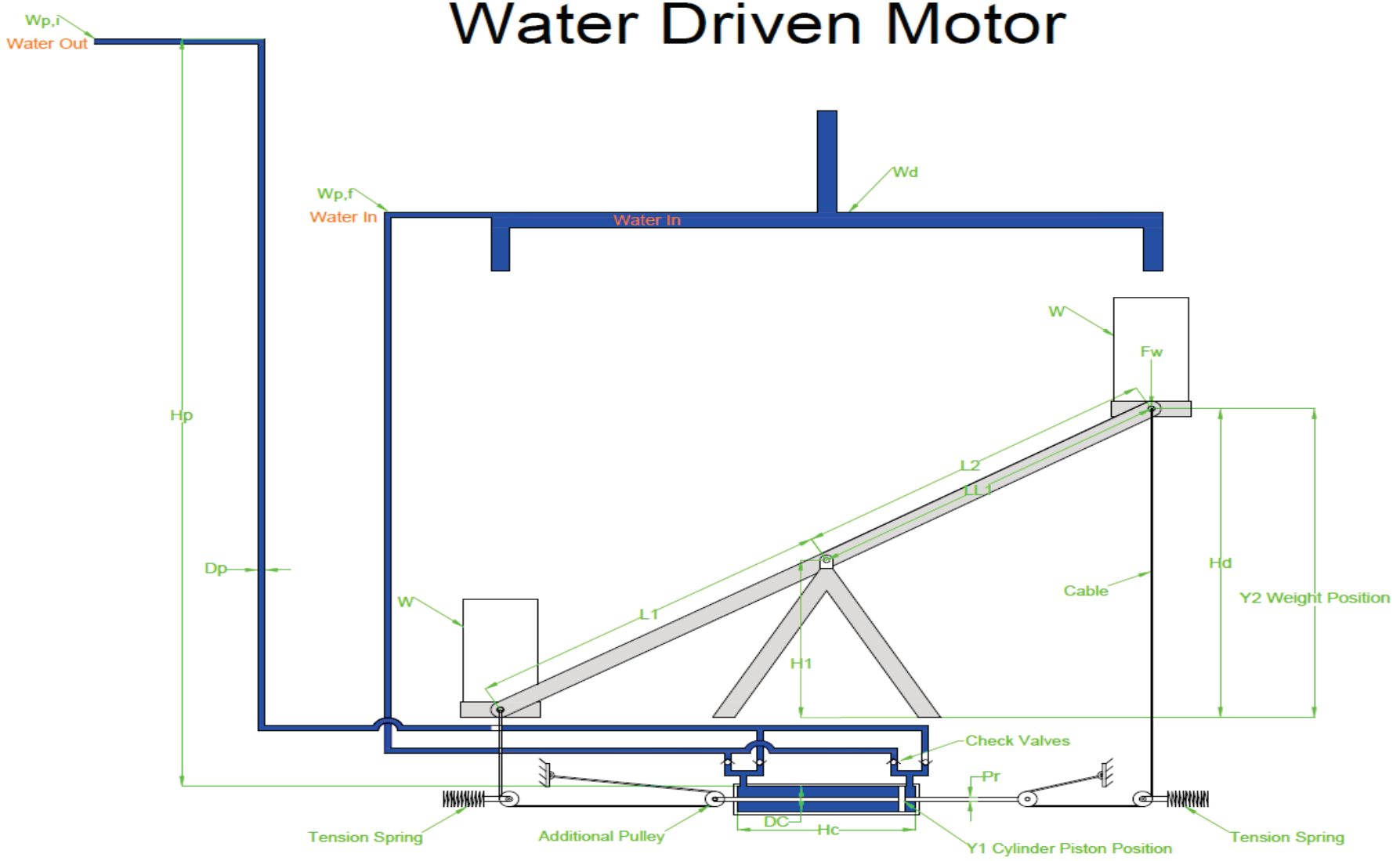
Volume = 251.3 ft^3

Weight = 15,673 lbs

Water – 62.4 lbs/ft^3

M T Water Motor with pump attachment

Water Driven Motor



Excel Computer Model

Water Motor with multi directional horizontal pumping cylinder

Water Motor with multi directional pumping horizontial cylinder

Inputs

Lever Arm - L_1	Lever Arm - L_2	Attachment Point of Cable from Fulcrum LL_1	# of additional pulleys for block and tackle	Additional Room for Pulleys	Gallons of Water Required in Tank to Complete Pumping Cycle	Water Flow - W_d	Required Water Flow - $W_{p,F}$	Piston Diameter - D_c	Piston Rod Diameter - P_r	Height of Water to be lifted - h_p	Daimeter of Pipe - D_p	Starting Angle of Lever	Final Angle of Lever	Magnetic Holding Force to Start Motion	Check Valve	Time Step - t	Friction Factor	# of 90° Elbows in Outlet Piping
(Ft)	(Ft)	(Ft)		(Ft)	(gal)	(GPM)	(GPM)	(inch)	(inch)	(Ft)	(inches)	(deg)	(deg)	(lb)	(in)	(sec)		
20	20	20	1	1	500.0	500	500.0	6	0.75	50	8	32	-32	100	8	1	0.02	2
		Must not exceed length of L1				Cylinder Piston Net Area		27.8	in^2			Angle must satasify cell D16 with a Pass, or angle is too great			(K)			(K)
						Pipe Flow Area		50.27	in^2						100			30

Outputs

Outlet Flow	Volume of water in riser pipe	Vertical Travel of W - H_d	Piston Stroke - h_c	Outlet Water Weight	Min. Water Height - H_d	Min. Fulcrum Height - H_1	Time at Which Pumping Starts	Time at Which Pumping Ends	Total Half Cycle Time	Average Pumped Flow Rate	Water Weight of full tank - F_W	Time to fill tank - T_f	Equivlant Length of Outlet Piping	Flow Rate		Cycle Time	
(gal/stroke)	(gal)	(inch)	(inch)	(lb)	(inch)	(inch)	(sec)	(sec)	(sec)	(GPM)	(lb)	(sec)	(inch)	Time	Flow Rate	Time	Flow Rate
15.32	130.56	254.4	127.2	1087.56	254.4	127.2	6.00	7.0	7.0	131.35	4165.0	60	2520.0	0	131.35	7.0	0
		(ft)	(ft)		(Ft)	(Ft)	(min)	(min)	(min)			(min)	(FT)	180	131.35	7.0	761.47
		21.20	10.60		21.20	10.60	0.100	0.12	0.12			1.00	210.00				
			Max Cylinder Length														
Notes			11.73	Pass													

Model Derived - Raised Flow Rates and Efficiencies

Feed Water Rate, Wd (GPM)	Avg. Pumped Flow Rate (GPM)
500	87.0
400	71.2
300	52.2
200	35.6
100	17.8

100 ft
17%

Feed Water Rate, Wd (GPM)	Avg. Pumped Flow Rate (GPM)
500	156.7
400	130.6
300	97.9
200	65.3
100	32.6

50 ft
32%

Feed Water Rate, Wd (GPM)	Avg. Pumped Flow Rate (GPM)
500	261.1
400	213.6
300	156.7
200	111.9
100	57.3

30 ft
52%

Accumulated Raised Storage

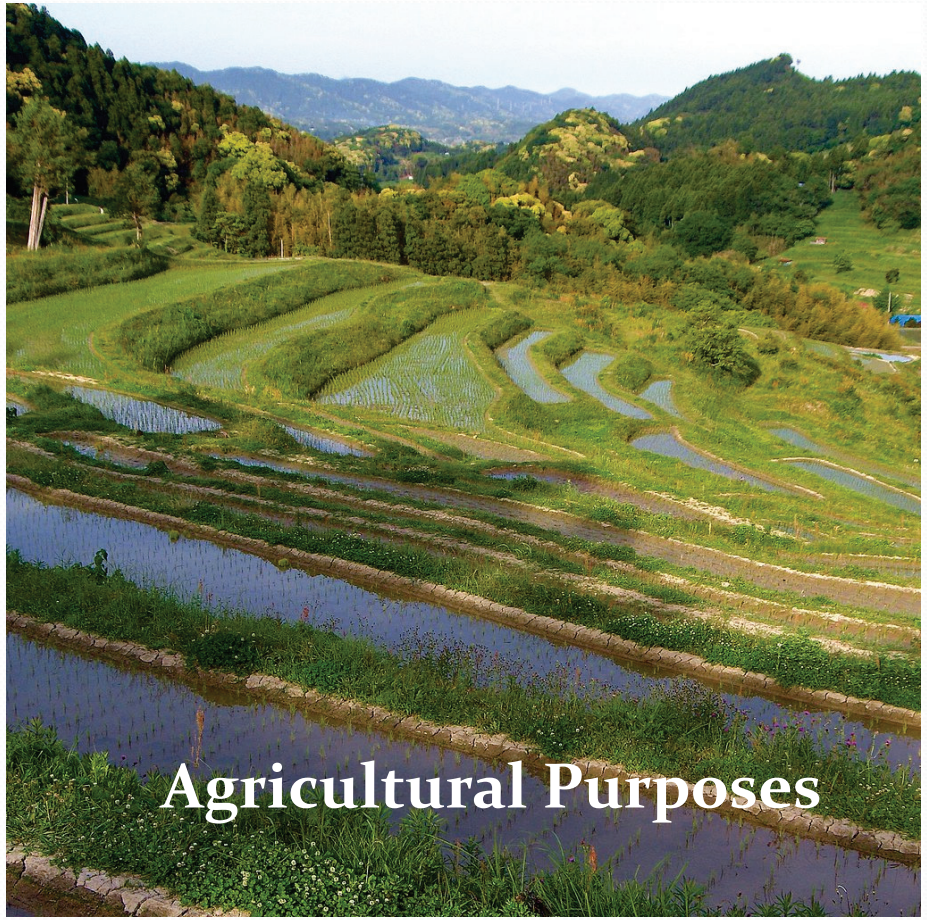
Gal/Minute	Gal/hour	Gal/Day	Gal/Week	Gal/Month	Gal/Year
50	3,000	72,000	504,000	2,016,000	24,192,000
100	6,000	144,000	1,008,000	4,032,000	48,384,000
150	9,000	216,000	1,512,000	6,048,000	72,576,000
200	12,000	288,000	2,016,000	8,064,000	96,768,000
250	15,000	360,000	2,520,000	10,080,000	120,960,000
300	18,000	432,000	3,024,000	12,096,000	145,152,000

(Assuming perpetual flow)

Raised Water Storage

Electric Pump or MT Water Pump		Fill-Time , days			
		Pumping Rate, (gpm)			
		50	100	150	200
Raised Water Storage		Pumping Rate, (gph)			
Acre Feet	Volume	3000	6000	9000	12000
1	326,000	4.5	2.3	1.5	1.1
2	652,000	9.1	4.5	3.0	2.3
3	978,000	13.6	6.8	4.5	3.4
4	1,304,000	18.1	9.1	6.0	4.5
5	1,630,000	22.6	11.3	7.5	5.7
6	1,956,000	27.2	13.6	9.1	6.8
7	2,282,000	31.7	15.8	10.6	7.9
8	2,608,000	36.2	18.1	12.1	9.1
9	2,934,000	40.8	20.4	13.6	10.2
10	3,260,000	45.3	22.6	15.1	11.3
11	3,586,000	49.8	24.9	16.6	12.5
12	3,912,000	54.3	27.2	18.1	13.6
13	4,238,000	58.9	29.4	19.6	14.7

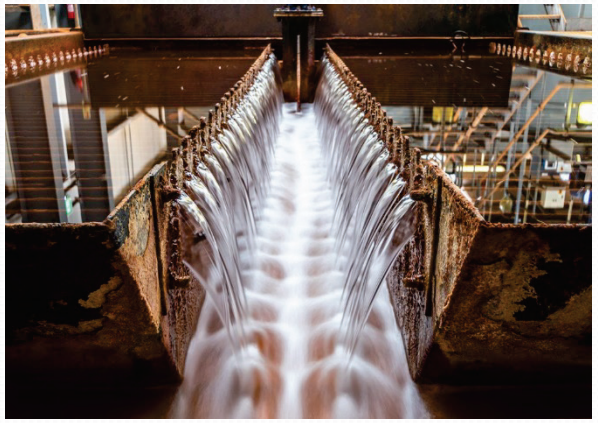
What Raised Water Storage Can Look Like

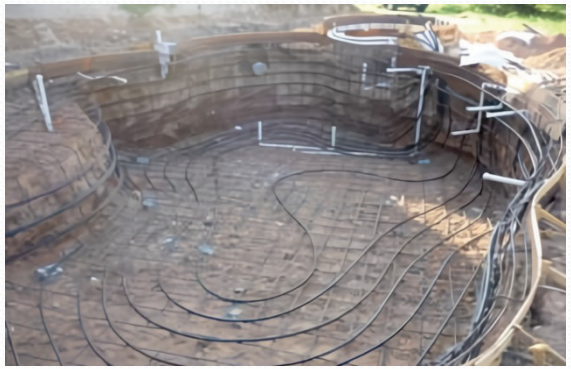


Beneficial Uses of raised water

- Supplement electrical power costs using conventional hydropower to harvest raised water storage created by the motor water.
- Expanded space for passive and active water treatment.
- Create hydropower fueled "*vehicle battery charging stations*" in *remote locations* with low head flow and without infrastructure access.
- Create Recreation and Fishing Lakes and Ponds, Wildlife Habitat.
- Development of residential, commercial, and industrial geothermal heating & cooling opportunities with raised surface impoundments or buried tank farms.

Geothermal Opportunities





Based on 2006 energy prices, geothermal heat pump systems using mine water could reduce annual costs for heating by 67% and cooling by 50% over conventional methods (natural gas or heating oil and standard air conditioning).

Watzlaf, G.R. and T.E. Ackman, Underground Mine Water for Heating and Cooling using Geothermal Heat Pump Systems. Technical Communication, Mine Water and the Environment, 2006.

Coupling Water Powered Technologies

Proven Water-Powered Technologies

- The MT water motor can raise water for perennial or intermittent operation of existing water-powered treatment technologies.

Tipping Bucket Lime Feeder

Aquafix Water Powered Augar

Limestone Diversion Wells

In-Line System

Small scale
< 100 gpm

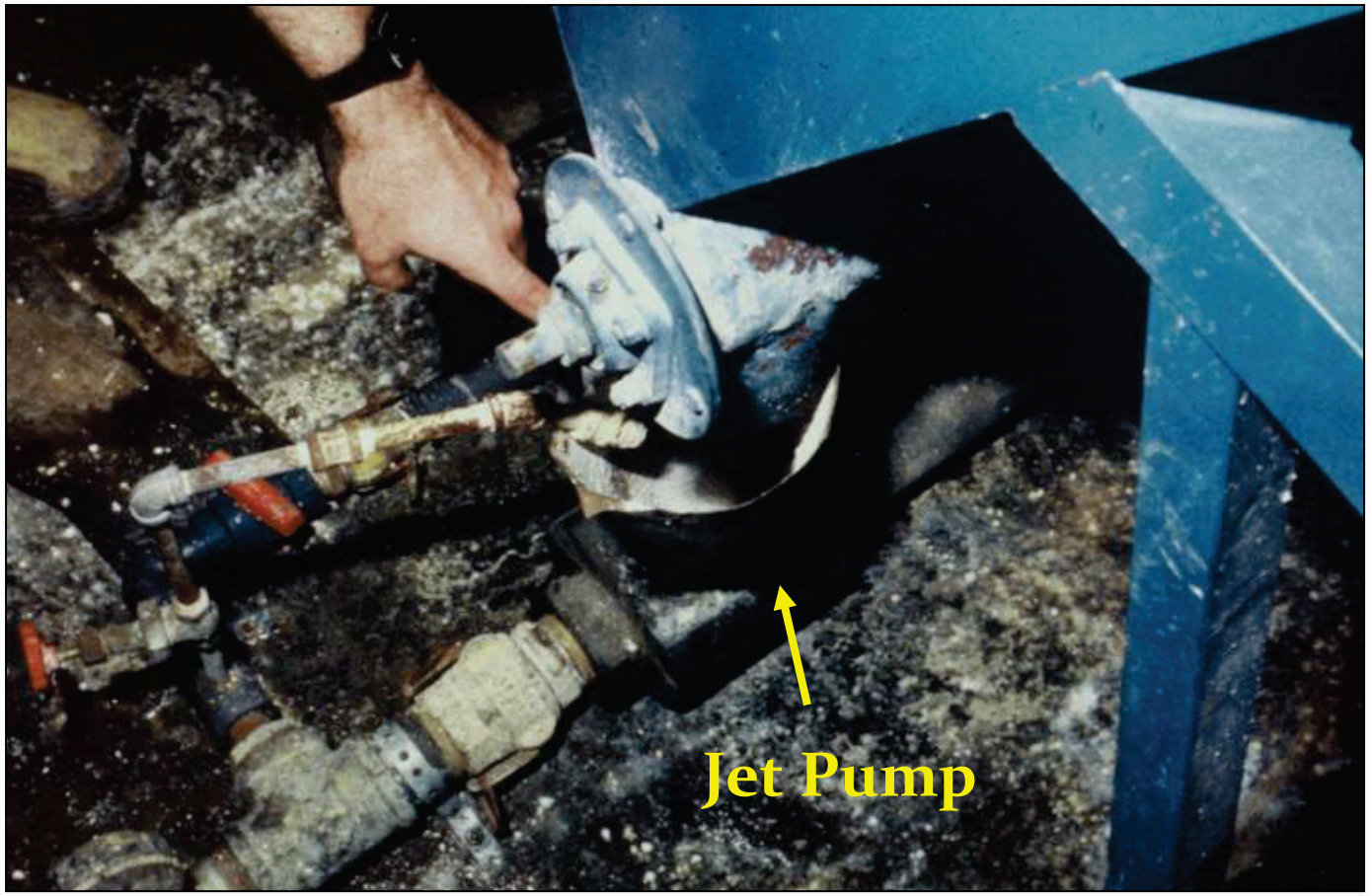
Industrial Scale
~1,600 gpm

Underground Treatment Capabilities

If the M T Water Motor were to be used, this would be considered the first underground semi-passive treatment system.

Two proven water powered technologies are coupled together and operated by a single electric mine pump.

Dry Chemical Feed – Water Powered Auger

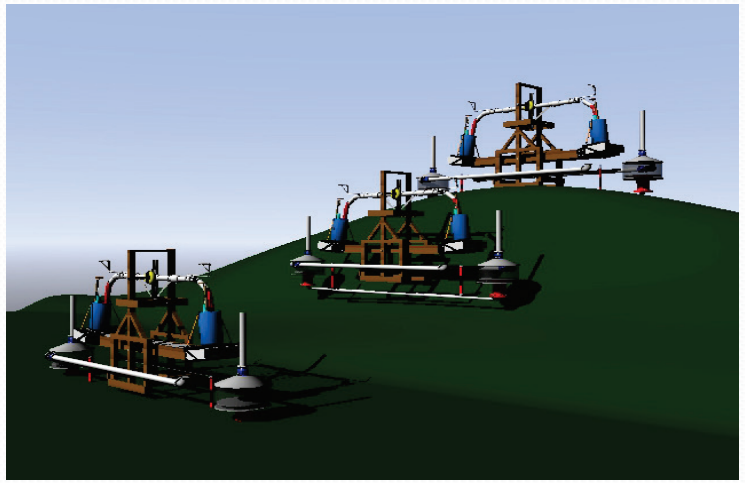


Pebbled Calcium Hydroxide

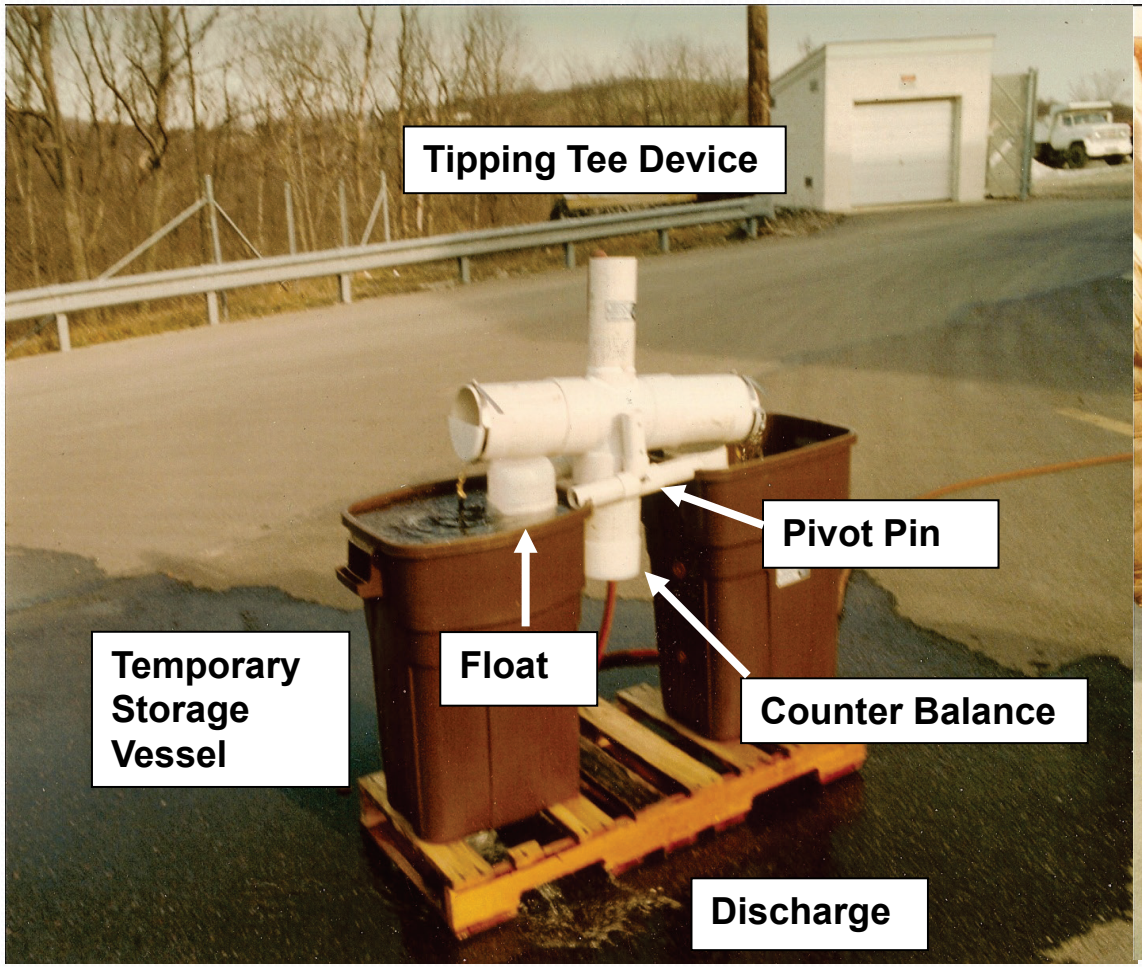
M T Water Motor (Water Management)

- Energy output can be **expanded with increased flow** and **split feeding of additional motors** placed in *"**parallel**"* at the same elevation. (top picture suggests how runoff and flood waters can be managed & harvested in parallel)

- Alternatively, the energy output can be **expanded without increased flow – by re-harvest.** Elevation change is needed and permits discharge to pass through down-gradient motors configured in *"**series**"*. A ~20 ft of head is needed between motors in downhill series.



Water Powered Flow Meter or Doser or Both?



Future Efforts

- Coupling of conventional technologies
- Develop Energy Storage & Conversion Technology to harness the significant forces created by the MTWM, e.g.,:
  - Fly Wheel Motors
  - Hydraulic Motors
  - Compressor Motors
  - Mechanical Devices

Compressor Motor

Hydraulic Motor

Flywheel Motor

Flywheel

Summary of Low Head Water Motor

Typical Head: ~10-20 Ft

- Temp. storage and release water regardless of quality
- Uses *Potential*, rather than *Kinetic* Energy
  - Meaningful range of energy output from a fixed head.
- Low Cost, Small Footprint
- Perm/Intermit operation

- No GHG emissions
- Multiple output capability (power/pump/compress)
- Durable design and operational simplicity enhances potential users' uptake, acceptance, and sustained use
- Highly efficient water use


QUESTIONS?