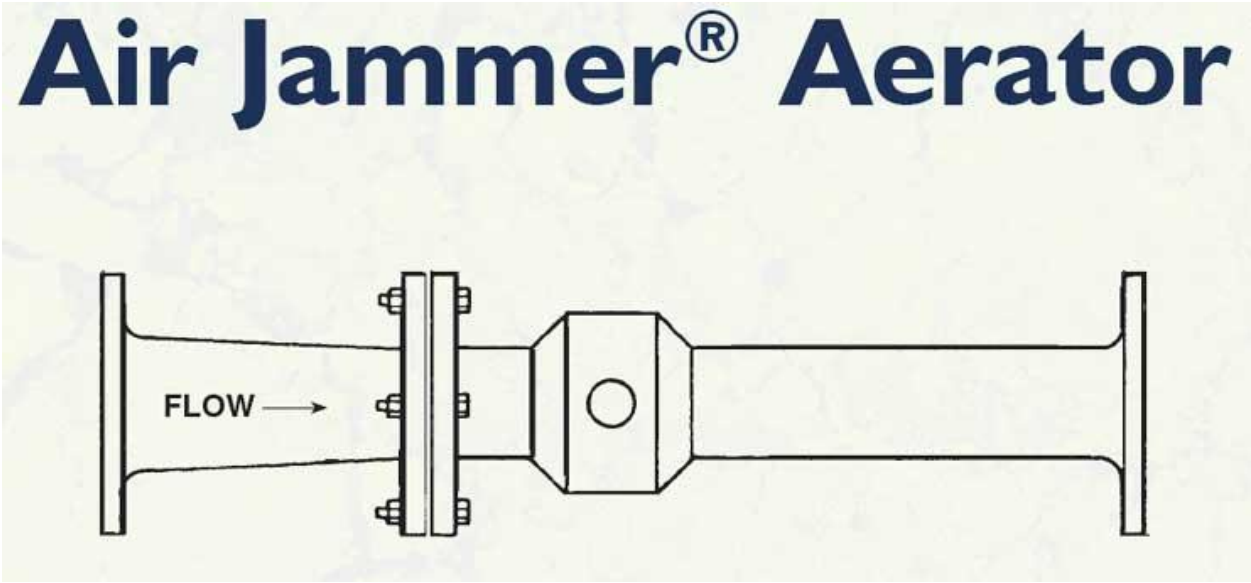
AIR JAMMER :
CUTTING AMD COSTS AT WARWICK MINE ON A LIMITED BUDGET



Charles K. Blankenship, P.E. Duquesne Light Company

A. Robert Marmo, P.E. Marmo & Associates

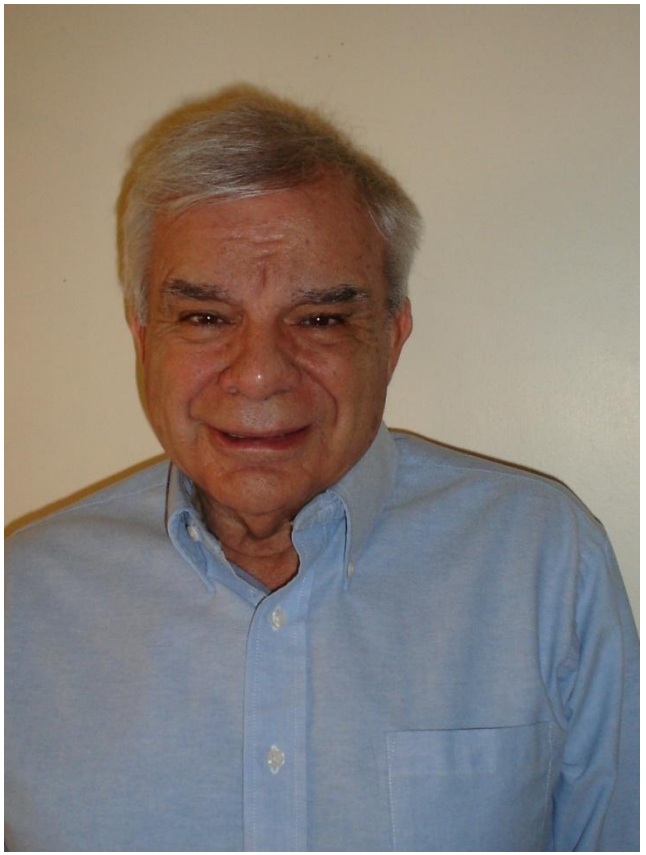
PRESENTED AT THE

WEST VIRGINIA MINE DRAINAGE TASK FORCE SYMPOSIUM

MARCH 30, 2011

AIR JAMMER :
CUTTING AMD COSTS AT WARWICK MINE ON A LIMITED BUDGET

Charlie Blankenship, P.E.
Director, Operations Services
Duquesne Light Company



Bob Marmo, P.E.
President
Marmo and Associates

INTRODUCTION

- Mine Water Drainage (MWD) can be expensive to treat.
- At Duquesne Light Company's Warwick MWD plant, these costs are perpetual

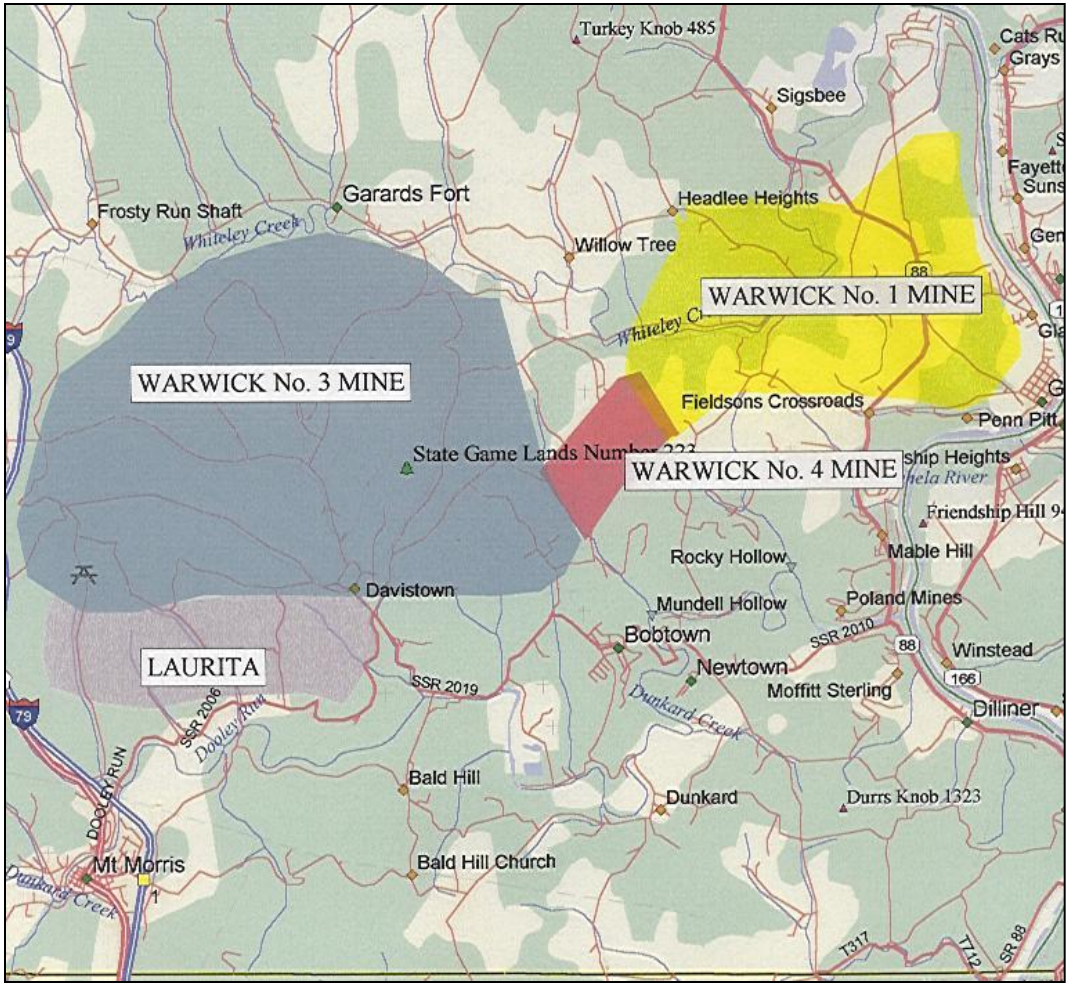
INTRODUCTION

- Duquesne has teamed with Marmo and Associates to reduce MWD costs at Warwick through improved aeration.

THE WARWICK PROJECT

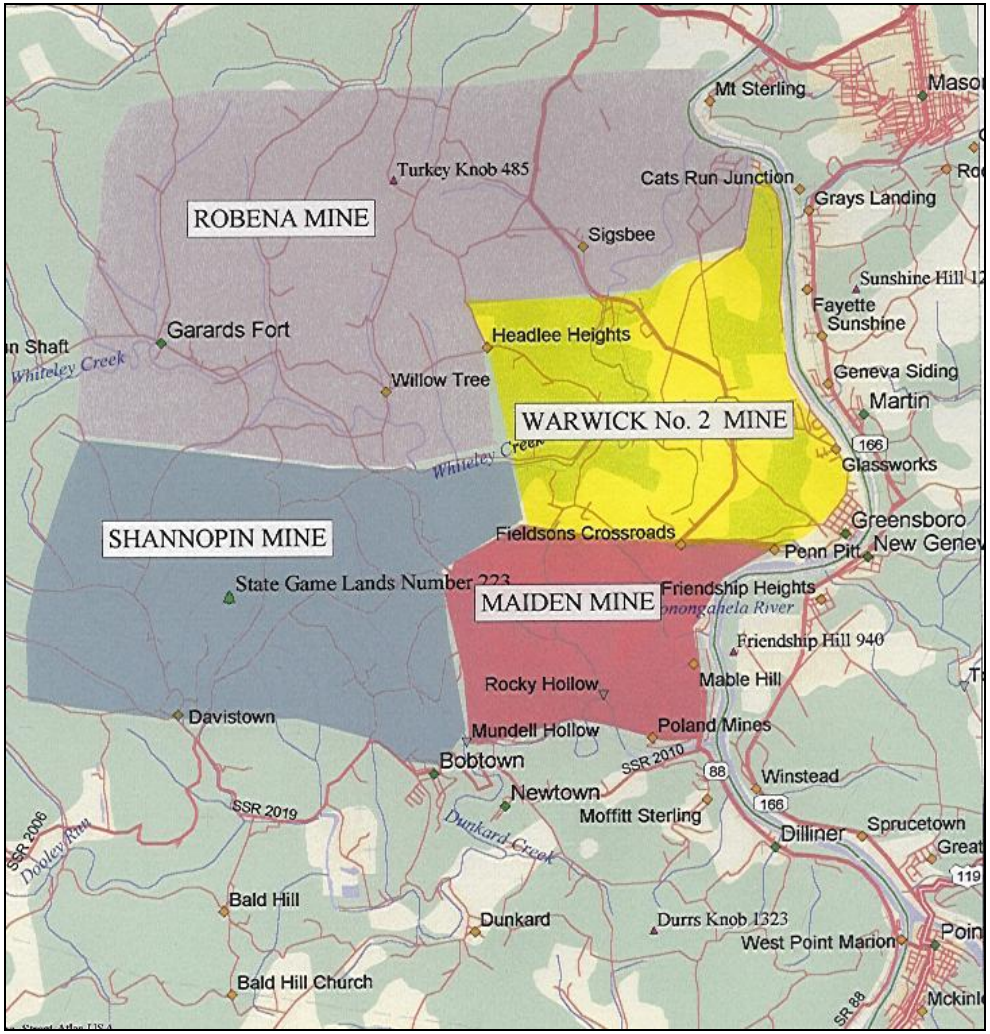
- In the 1930's, DLC bought mines and properties in Greene County, PA to serve its power plants. The last mine closed in February, 2000.

THE WARWICK PROJECT



- The Warwick No. 1 Mine is in the Sewickley seam and is drained by boreholes into the Pittsburgh seam below.

THE WARWICK PROJECT



- The Warwick No. 2 Mine is in the Pittsburgh seam. DLC pumps and treats water from this pool for release into Whiteley Creek.

THE WARWICK PROJECT

- DLC sealed all of its old openings along the Mon, but has no desire to “pressure-test” them, thus the mine pool is kept below 800’ asl .

WATER TREATMENT

- Water is removed from Warwick No. 2 by up to four deep-well pumps capable of a total of 4,200 gpm, but averaging about 1,500 gpm, 24/7/52.

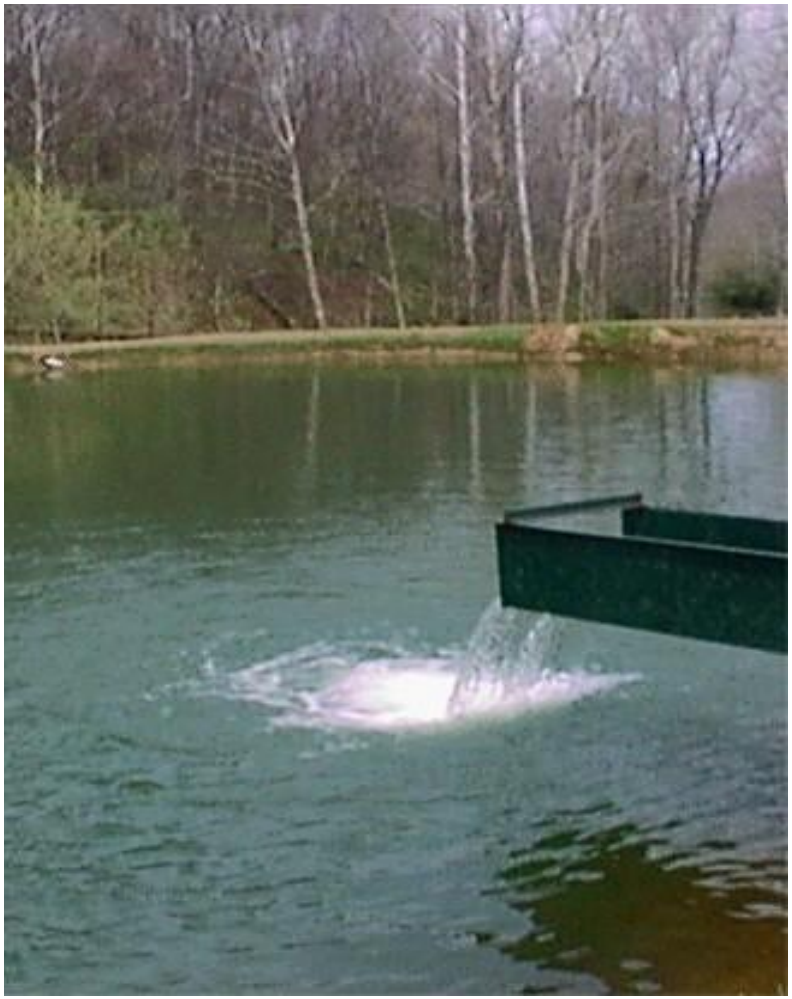
WATER TREATMENT

- A lime slurry is added, raising the pH to promote oxidation of iron. Historical lime use has been on the order of 160-165 tons per month at a cost of about $142/ton.

WATER TREATMENT

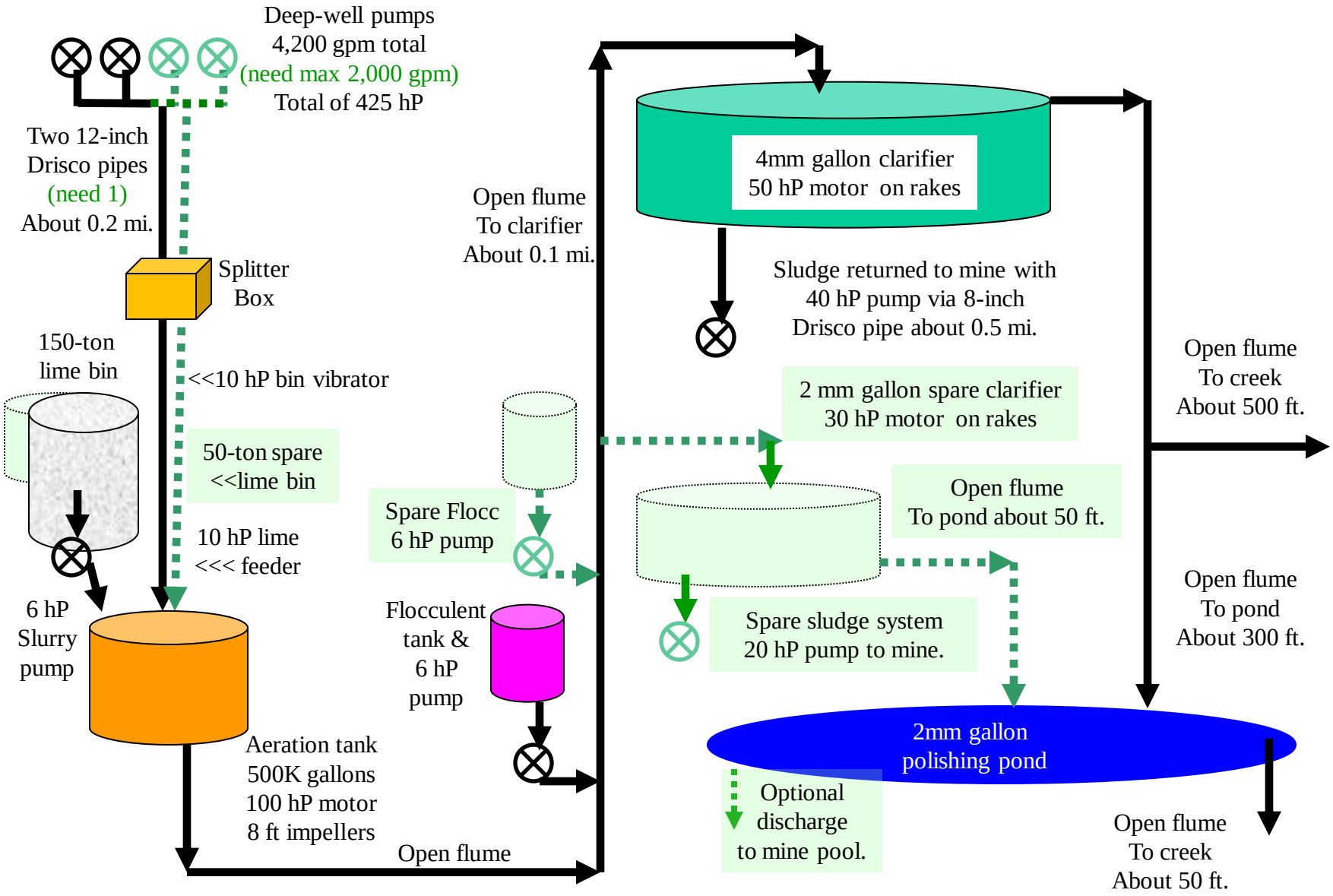
- The water is then aerated and a polymer is added to facilitate settling of solids in a 4mm gallon clarifier.

WATER TREATMENT



- After settling in a clarifier, clean water reports to a polishing pond and solids are returned to the mine

WARWICK AMD PLANT – OLD AERATION SYSTEM



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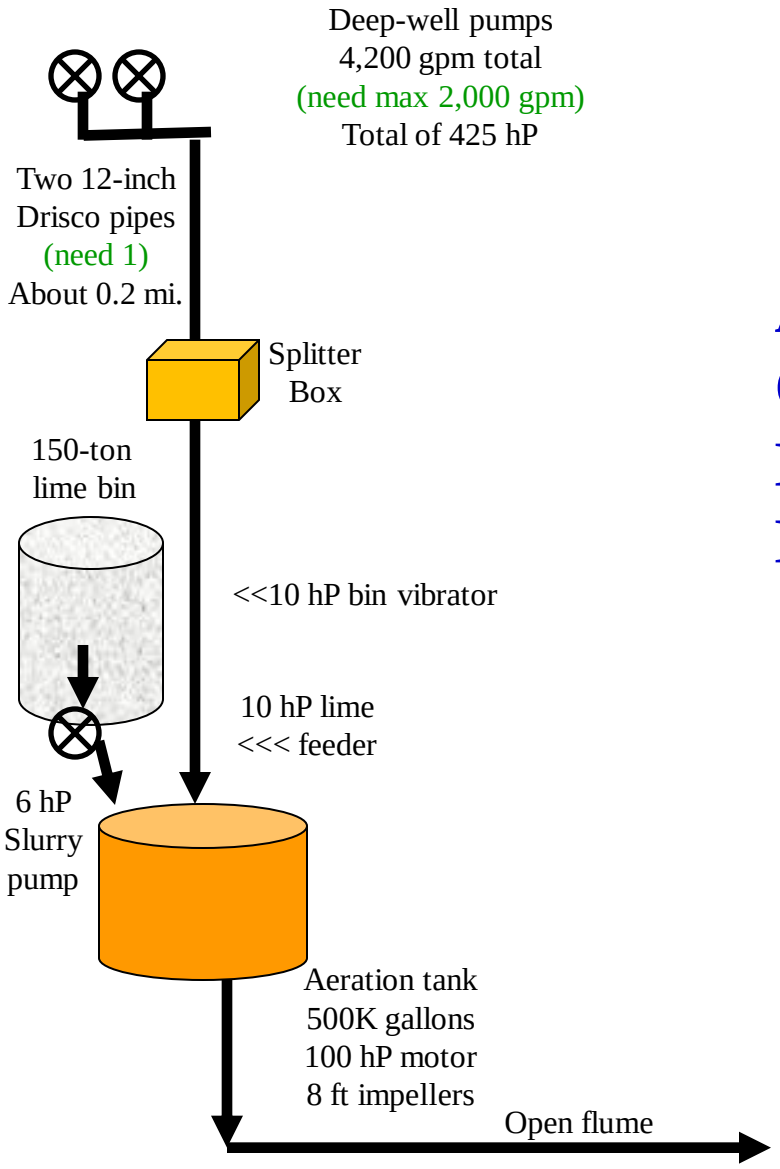
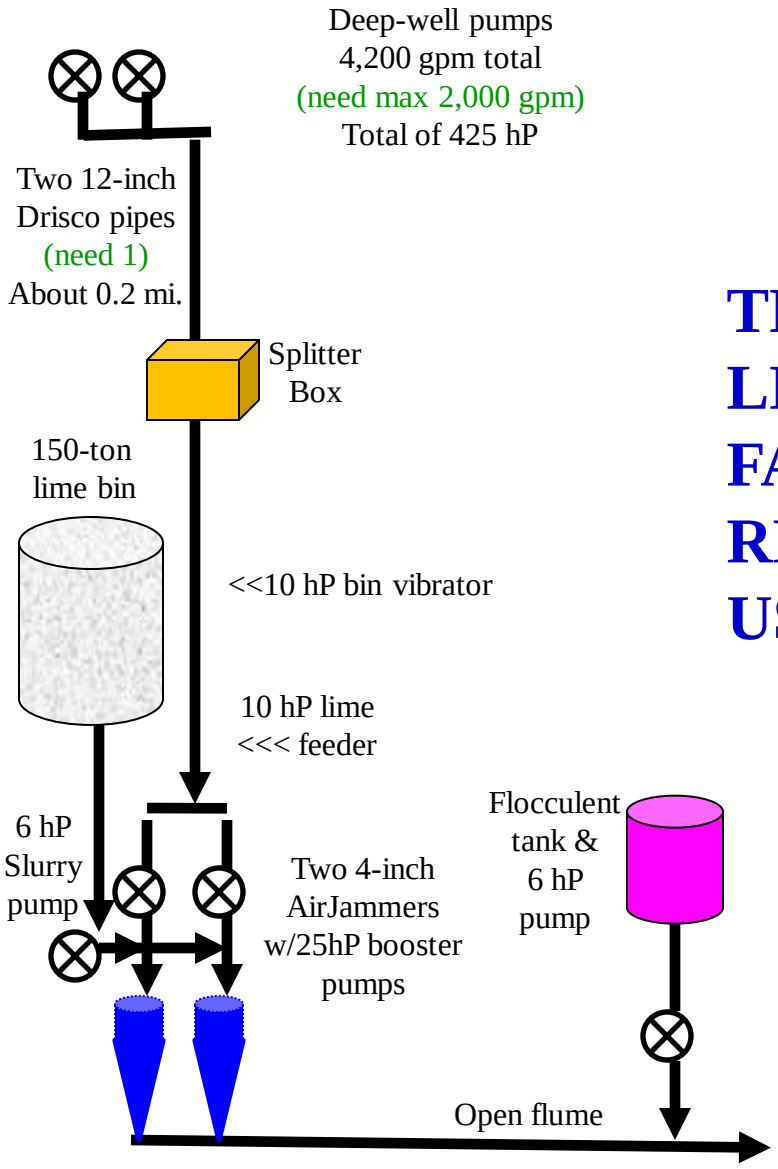


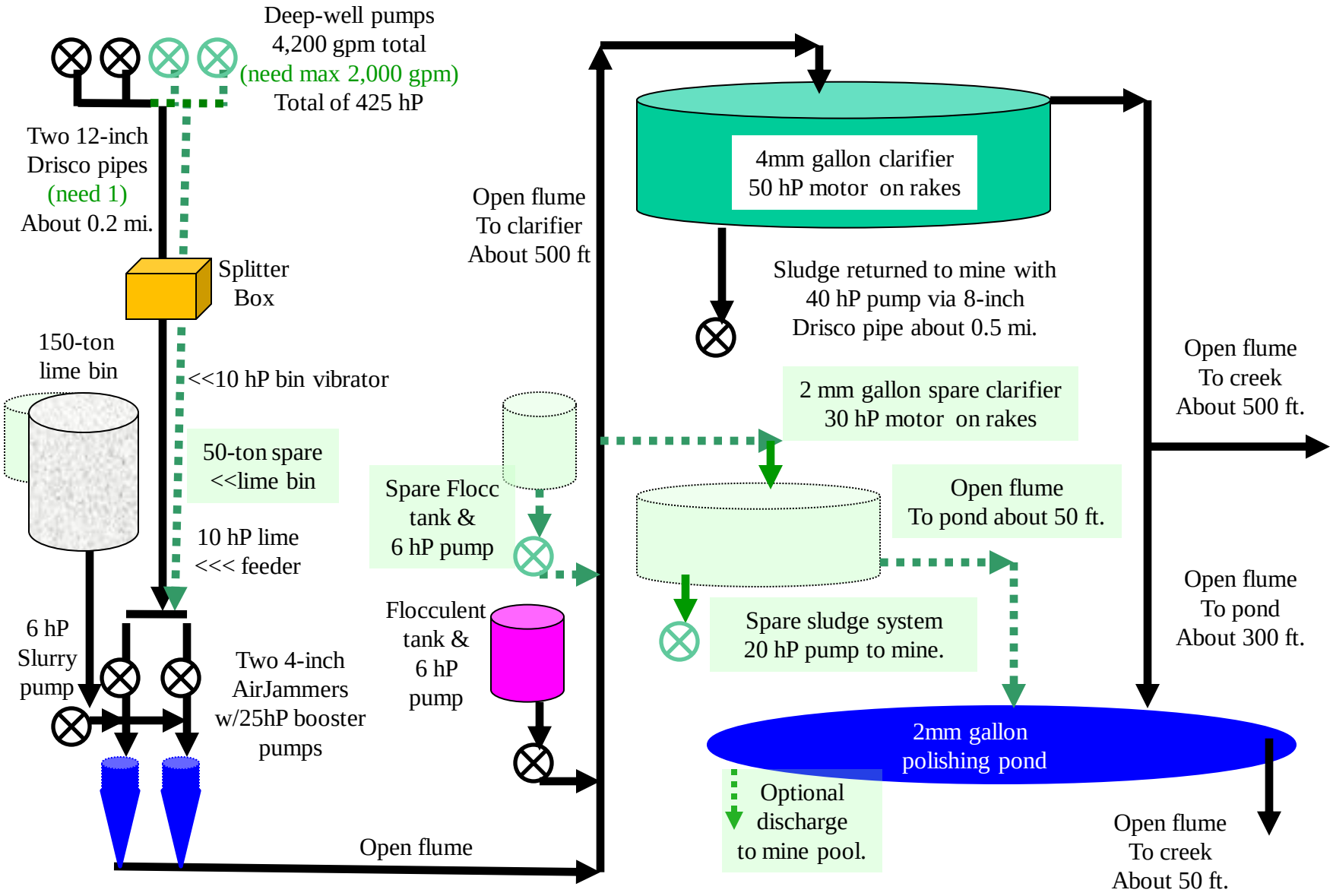
AERATION FOR THE ORIGINAL PLANT WAS ESSENTIALLY BY BRUTE FORCE.

WARWICK AMD PLANT – AIR JAMMER SYSTEM

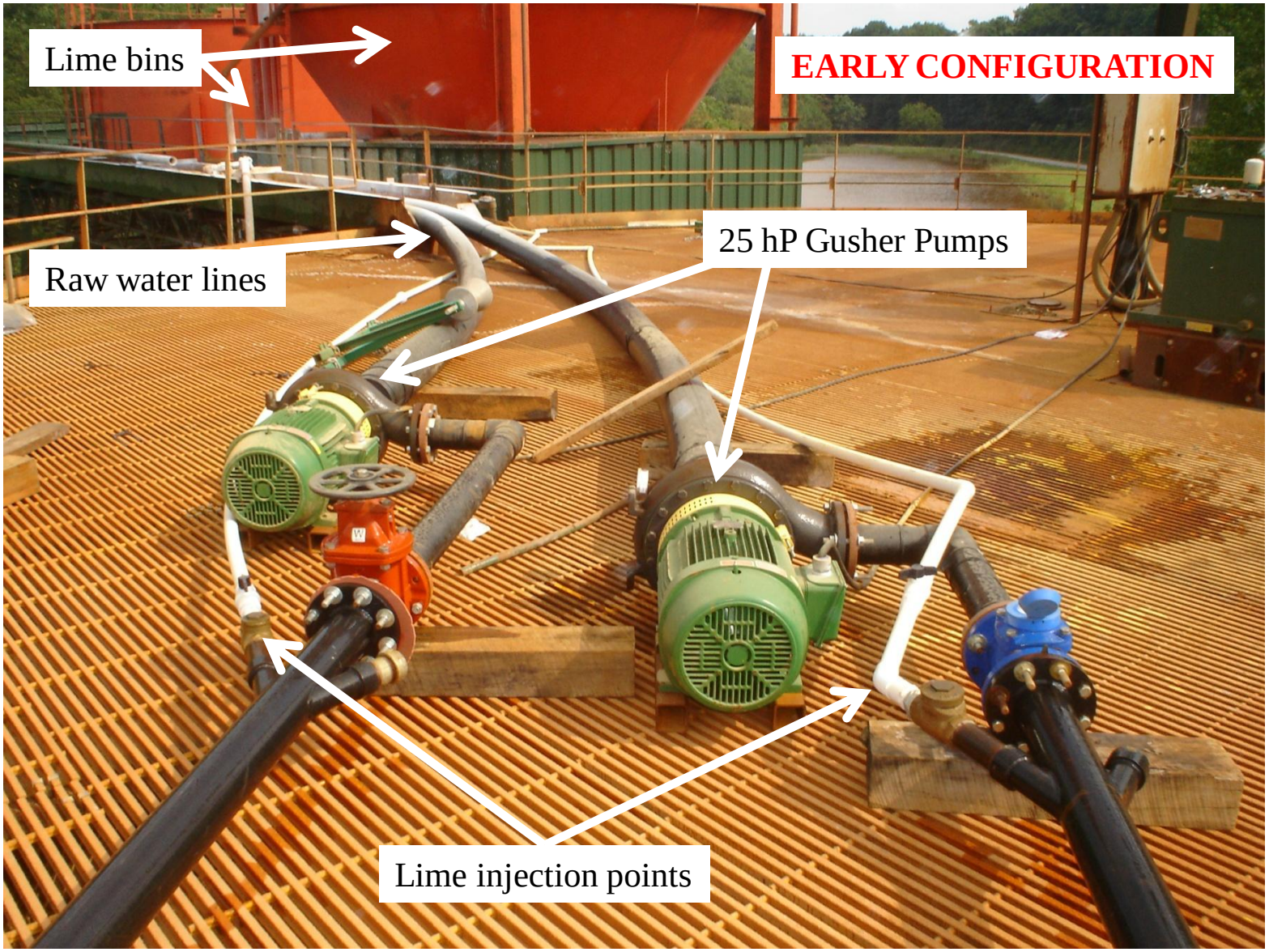


THE NEW SYSTEM USES LESS POWER AND ACHIEVES FAR BETTER AERATION, RESULTING IN LESS LIME USE AND LOWER COSTS.

WARWICK AMD PLANT – AIR JAMMER SYSTEM



WARWICK AMD PLANT – AIR JAMMER SYSTEM



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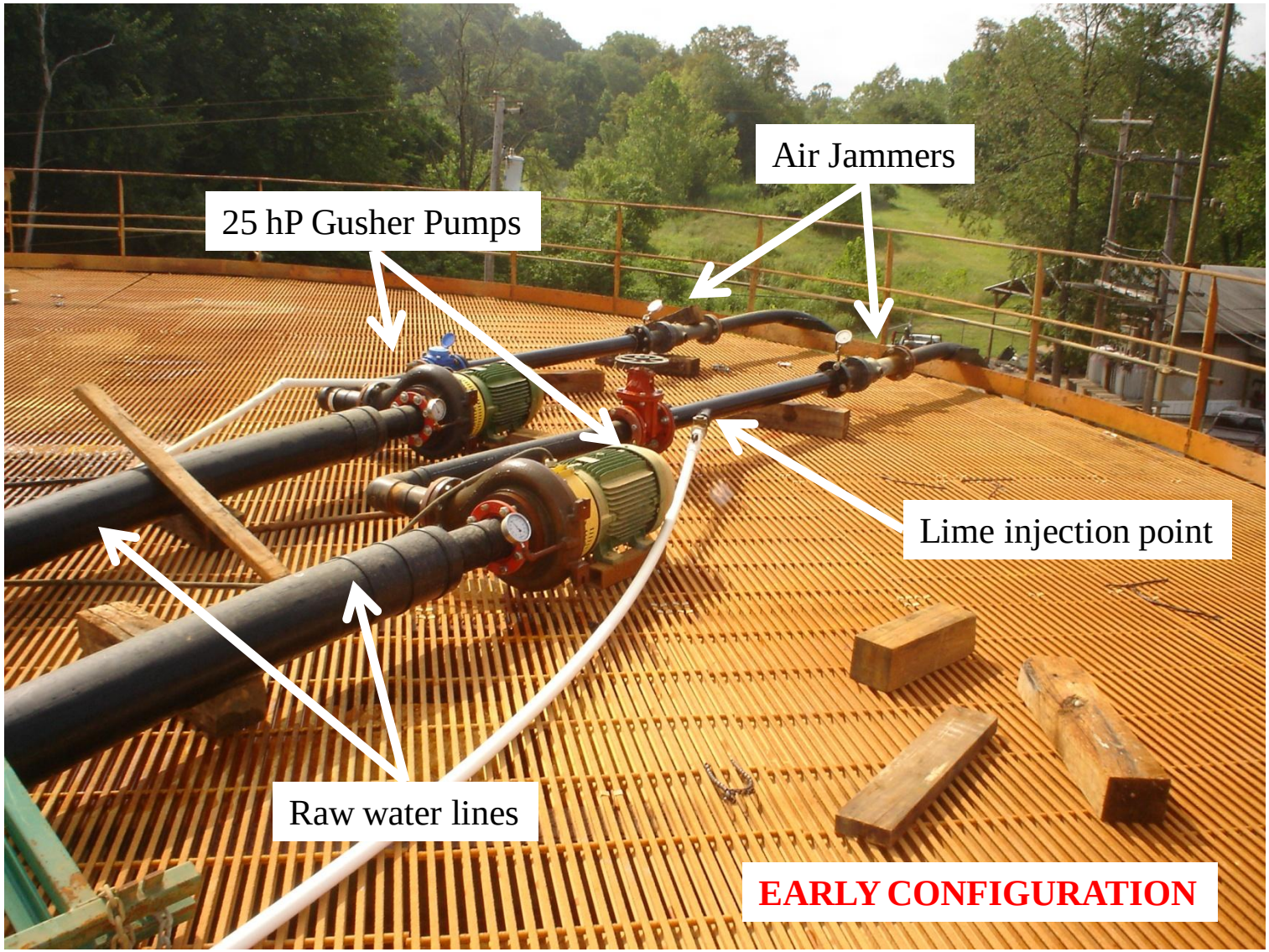

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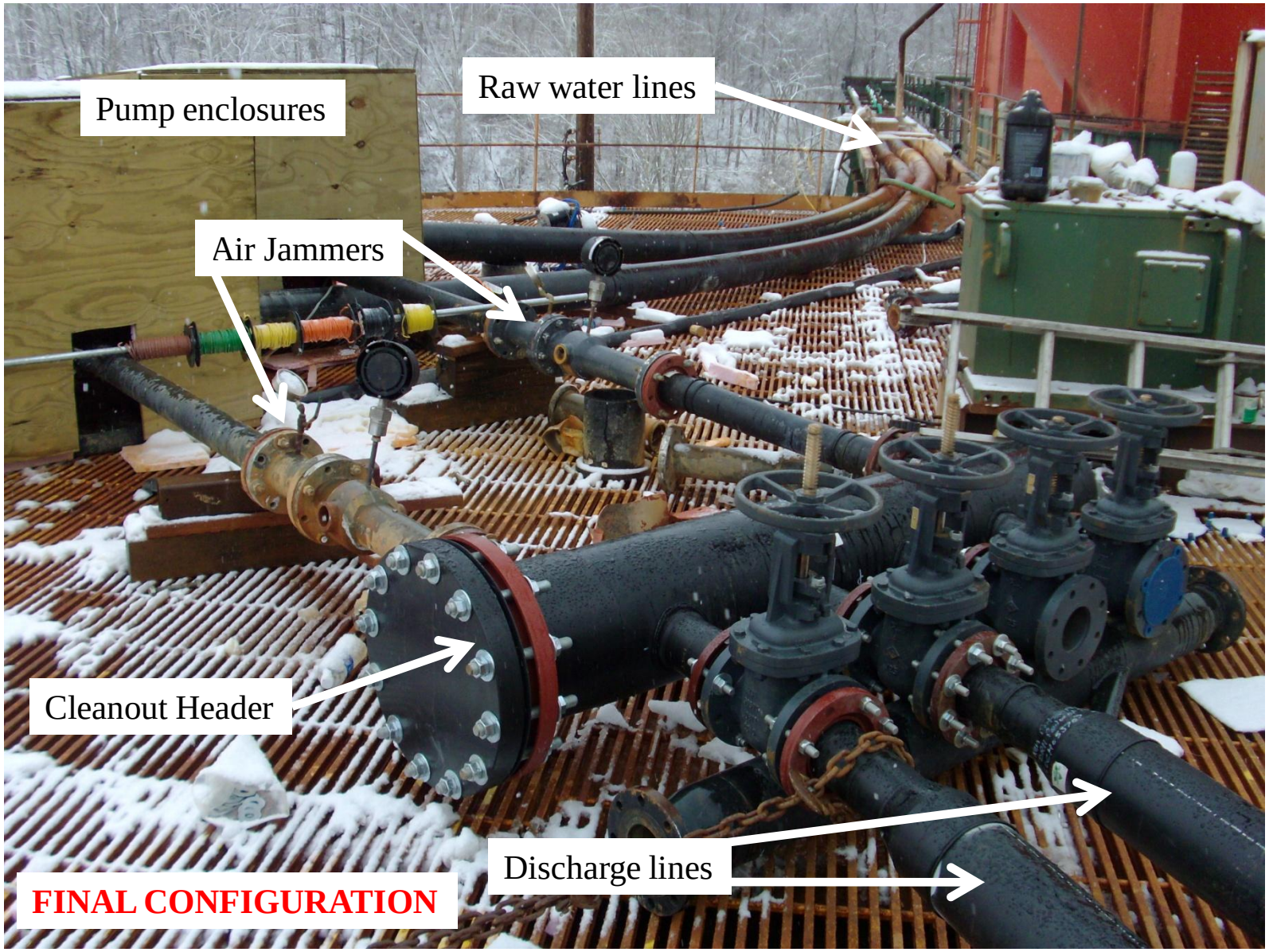

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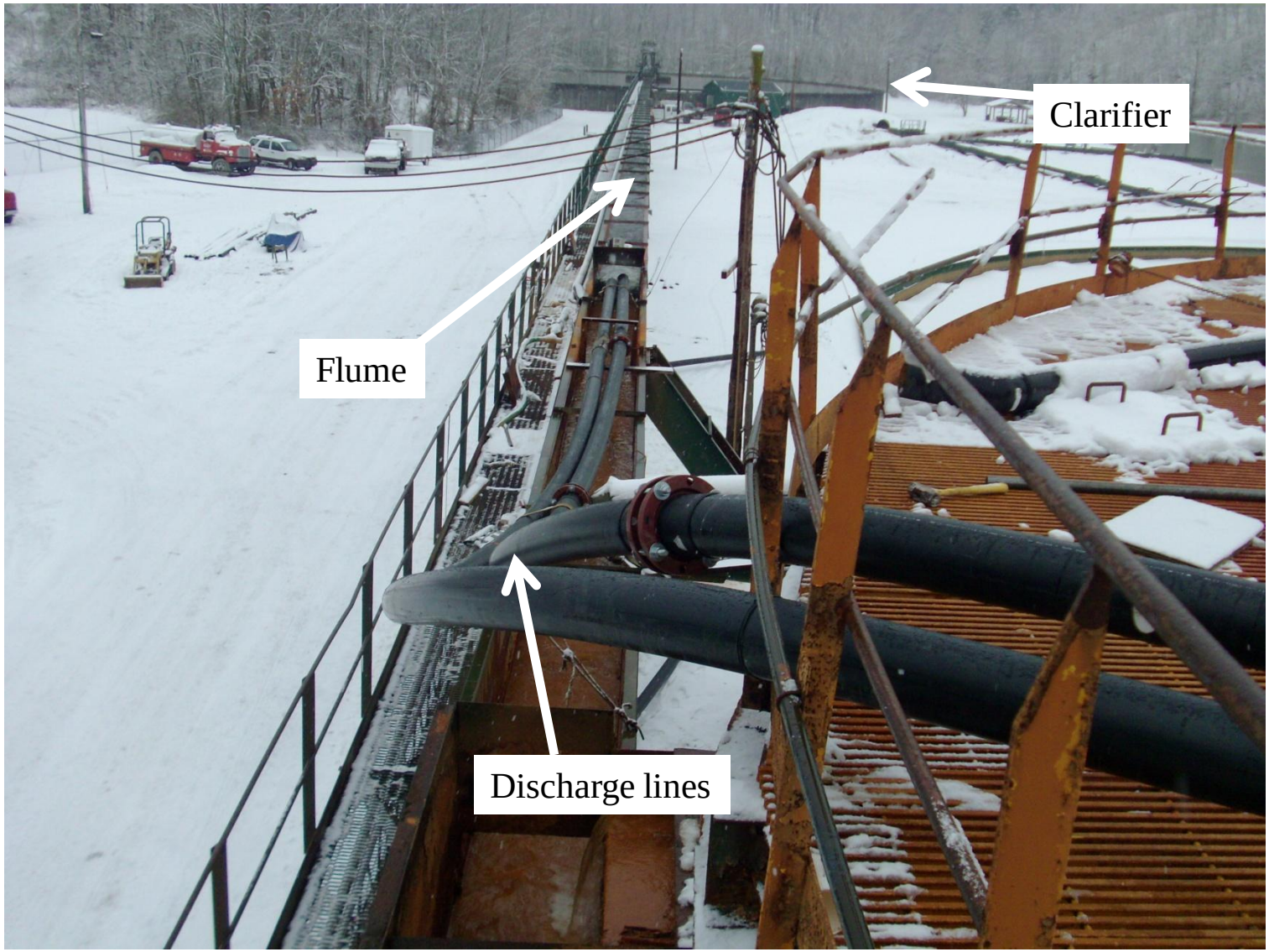
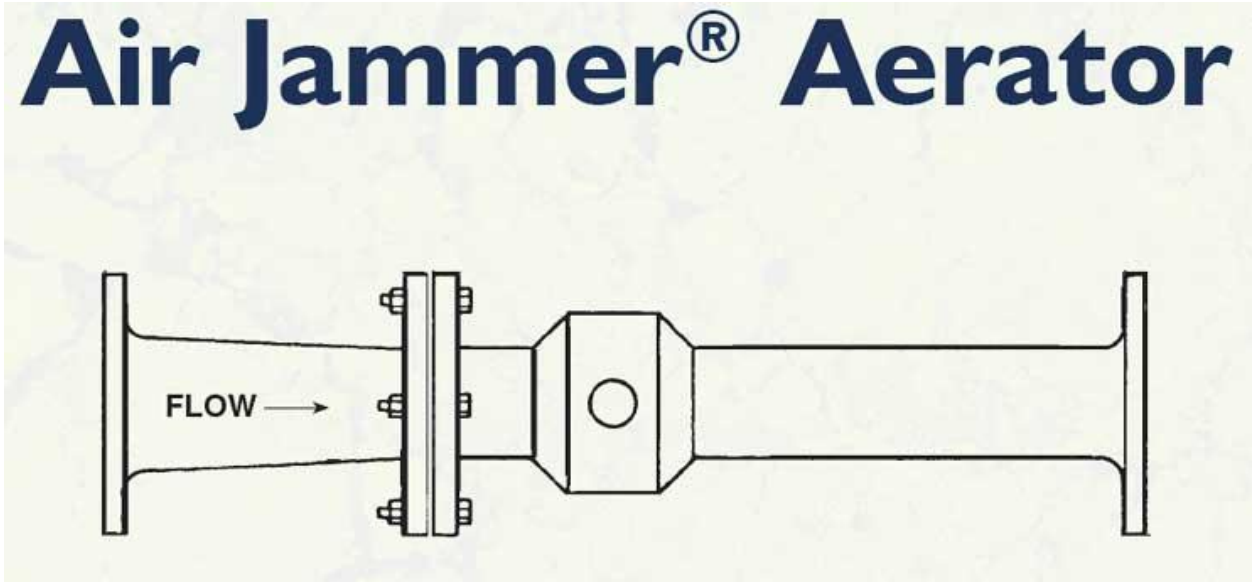


Air Jammer® Aerator



AIR JAMMER ADVANTAGES

AIR JAMMER ADVANTAGES

MIXING AND AERATION IN ONE OPERATION

- Supersonic nozzle creates accelerated velocity, shear and cavitation to produce oxidation and intimate mixing

HIGH EFFICIENCY AERATION

- Vacuum operation causes hydrodynamic cavitation and O_2 transfer rates above stoichiometric values
- As opposed to bubble diffuser contact only phenomena
- Every gallon of discharge passes through the Air Jammer

CO_2 STRIPPING

- Produced by shear and cavitation

SMALL FOOTPRINT

- In line educator concept much more compact
- Simpler, less expensive construction

AIR JAMMER ADVANTAGES (CONT.)

LOWER ELECTRICAL COST

- Air Jammer ½ power consumption of mechanical aerator

LOW MAINTENANCE

- Rugged construction
- No moving parts
- System can be automated

REDUCE OR ELIMINATE CHEMICALS

- Vacuum concept produces supersaturated oxidation
- High alkalinity discharge with low Fe with no chemical added

MODULAR CONCEPT FOR HIGH FLOW RATES

- With manifold design, use multiple Air Jammers on single pipe
- Can achieve flow rates of 7,000 to 8,000 GPM

WARWICK AMD PLANT – AIR JAMMER SYSTEM

TEST RESULTS

PARAMETER	OLD SYSTEM	AIR JAMMER SYSTEM
RAW WATER FLOW (gpm)	1,500	1,500
RAW IRON (ppm)	110 - 140	110 – 140
CLEAN IRON (ppm)	< 2.0	< 2.0
LIME FEED (lbs/hr)	450	32
LIME COST ($/hr @ $142/t)	$32.66	$2.32
INSTALLED hP (aerator)	100	50
KW DEMAND (total plant)	229	176
CAPITAL $ (aerator)	$500K	$50K (w/piping)

?

WARWICK AMD PLANT – FUTURE PLAN