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Powow River Horsepower, from 19th Century Textiles to 20th Century Electric Power Utility

Estimating horsepower actually realized along the Powow River, with accompanying photos and maps

by
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The Powow River

This stream rises in the town of Kingston, N. H., and flows by a very crooked course in a southeasterly and southerly direction until it finally joins the Merrimack River by a rather long tidal estuary, at a sharp bend opposite the northerly point of Newburyport. The basin is about 10 miles northwest and southeast, and about 4 to 6 miles wide, and has a drainage area above Gardner Lake of about 51 square miles. The average rainfall from 1893 to 1913 was 39.8 inches.

The basin is thinly settled, except for the village of Amesbury, near the mouth, which has about 8,500 inhabitants and a number of mills and factories. The general slope of the basin is rather flat, although dotted here and there with hills about 300 feet high, and the soil is sandy. It contains eleven ponds and reservoirs of sufficient storage capacity to produce a very even and serviceable flow, which develops considerable water power due to the fact that the fall or head is concentrated within a half mile of the outlet of Gardner Lake, the lowest pond in the system.

The total fall between East Kingston and the mouth, a distance of 9½ miles, has been computed by Professor Porter to be about 122 feet, of which about 85 feet occur within a half mile of Gardner Lake as above mentioned, where the actual developed head is 81 feet. The total area of all the ponds is over 2,200 acres, and the total storage, not including Gardner Lake is estimated at over 437,900,000 cubic feet, which is all under the control of one company.

The Powow River, described in a 1918 report of the Mass. Commission on Waterways and Public Lands. The full Powow River section of this document appears in the Appendix.

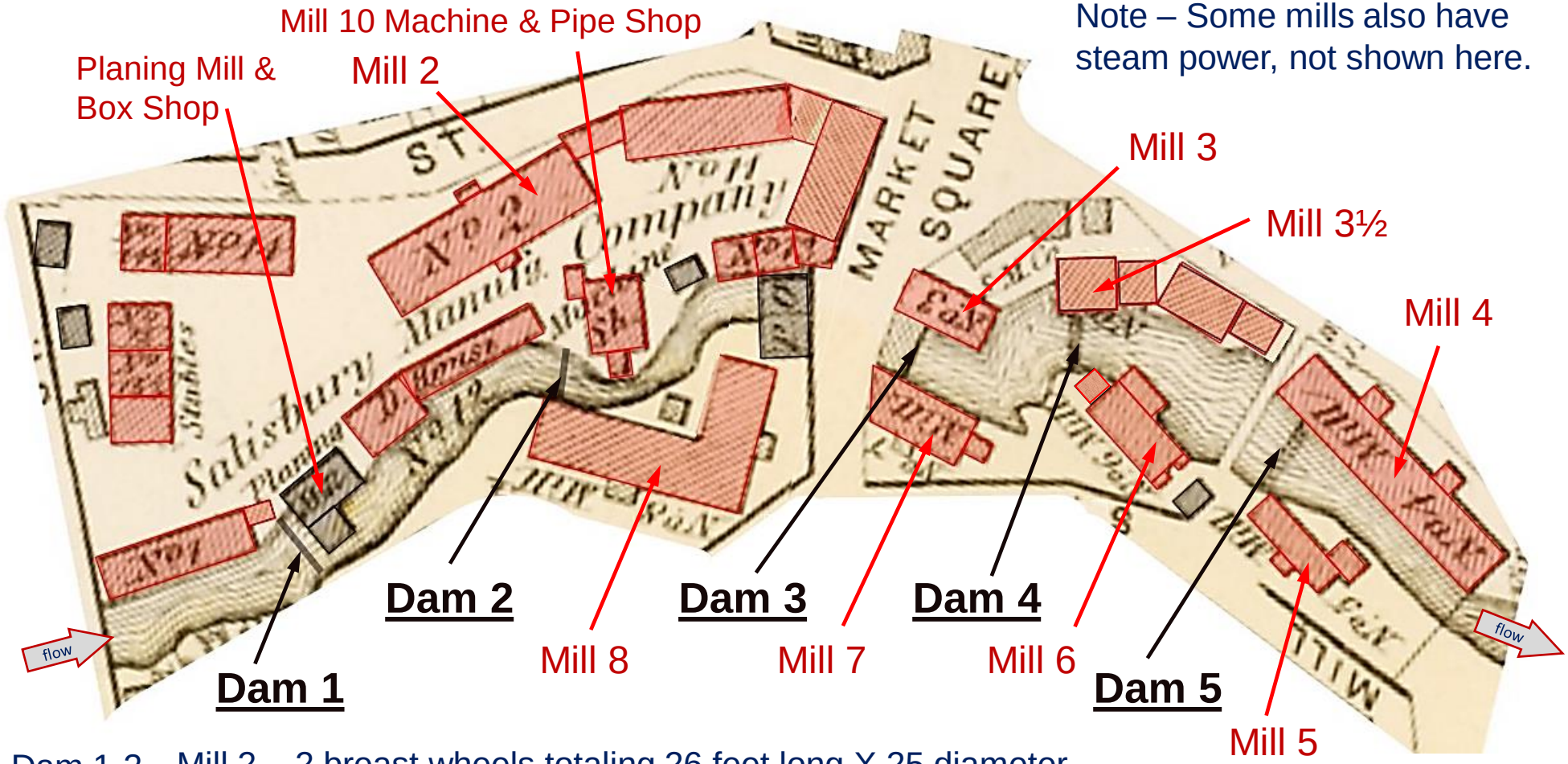
Introduction

The original intent was to estimate horsepower (HP) yield along the Powow River textile mill complex based on an 1878 inventory of power extraction equipment. It rapidly progressed into a two-part story because the textile complex transformed in 1916 into an electric utility company. The latter period enjoyed expanded reporting of events that provided far greater insight into technical details of the electrical era. That later information offered a reasonable means of estimating Powow River waterflow, the essential ingredient for calculating river horsepower, which could then be broken down by individual mills based on the 1878 inventory. The enabling data comprised a 1918 report on Massachusetts rivers (previous page), Sanborn Insurance Maps, and newspaper accounts of mill changes. The majority of important sources are in the Appendix.

This story thus furthers our understanding of Amesbury's growing industrial-scale lifestyle in the early 20th century, with such infrastructure and amenities as domestic electricity and water distribution from the town's 1910 electrically powered waterworks.

1878 Layout of Dams & Powered Mill Buildings

1872 map modified for 1878 mill inventory. River flows left to right, west to east.



Note – Some mills also have steam power, not shown here.

Dam 1-2 - Mill 2 – 2 breast wheels totaling 26 feet long X 25 diameter
Mill 8 – 4 breast wheels totaling 80 feet long X 25 diameter

Dam 3 - - Mill 3 – Kilburn turbine
Mill 7 – 2 Hunt turbines

Dam 4 - - Mill 3½ – Hunt turbine
Mill 6 – breast wheel 18 feet long X 17 diameter

Dam 5 - - Mill 4 – Kilburn turbine
Mill 5 – Hunt turbine

Note – Each dam serves two main mills on opposite sides of the river. Dams 1 & 2 function as a single dam for Mills 2 & 8. Dam 2, slightly mislocated here, also powers the Machine & Pipe shop.

What Results Can be Expected

Some definitions are required regarding historical hydropower data. Descriptions of power extraction equipment typically state maximum rated capability for continuous operation, not at all implying that it actually operated at that level. The operating levels designed for would be for "normal" average rates of waterflow expected during long periods, for which equipment should be optimally efficient. (Efficiency is a function of specific technology used, e.g. water turbines being more efficient than waterwheels.) There would be high waterflow spells possible for an extended time, such as an unusually wet spring, during which water wheels would be negatively impacted and turbines could be also. There would also be droughts, known to have closed the mills for weeks and longer, typically hedged against using supplementary steam power.

Waterflow varying with climate, our horsepower "expectations" might depend on how our climate compares to that of the 19th century. On one hand, current Amesbury annual rainfall of 56 inches is overly optimistic compared to the above quoted 39.8 inches average for 1893 to 1913. On the other hand, the river is already in drought this year (2022) for the third time in six years, contrasting with the "Mothers' Day" floods of 2006. Historical waterflow is difficult to formulate.

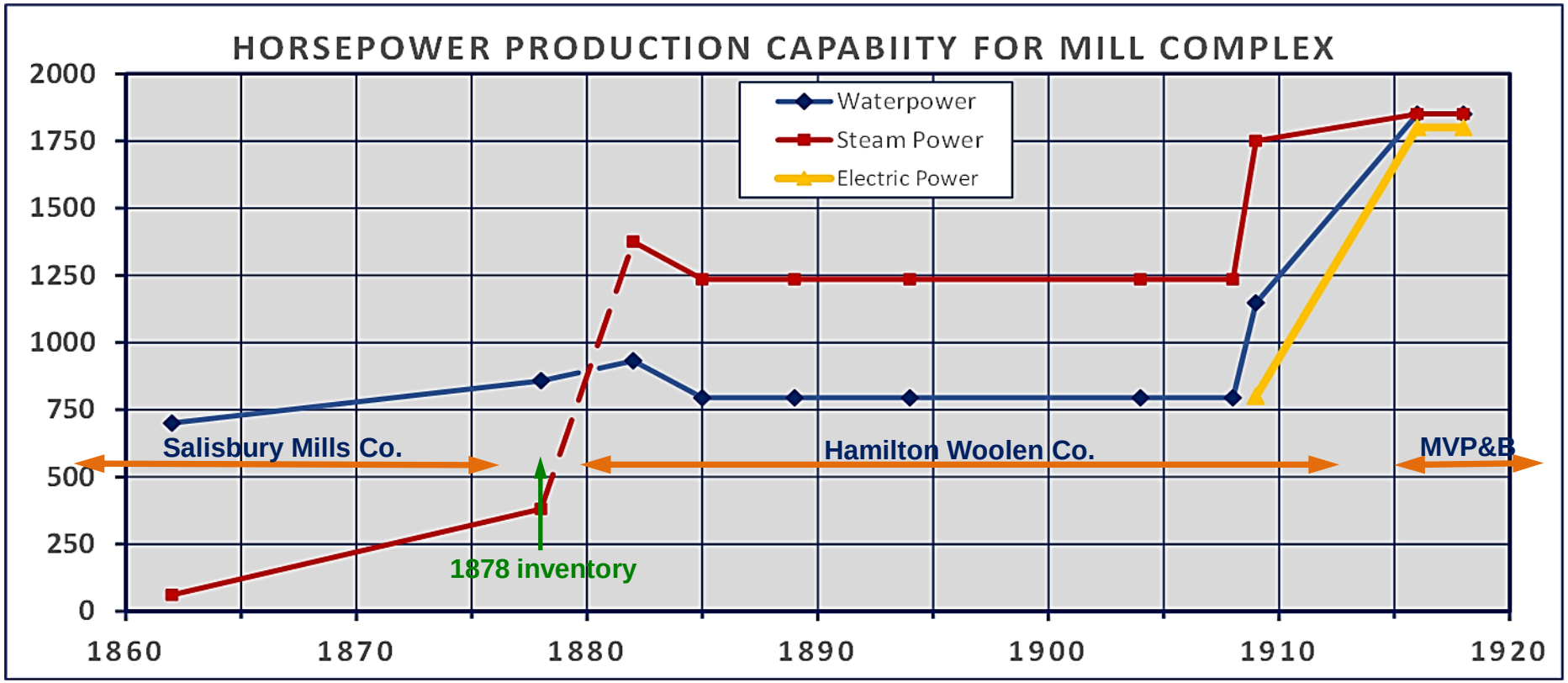
With the above provisos, there are three brief historical design-horsepower estimates for the mill district. An August 1909 news article stated mill hydro-power of 1000 HP[1]. A 1918 report of the Massachusetts Commission on Waterways and Land Use (see appendix) mentions for the mills "a total installed capacity of 1000 horsepower was only available for about three months of the year" during some undefined previous period[2]. A 1910 report in the *American Wool & Cotton Reporter*, (see appendix) seemingly describes recently modernized "waterwheel" (certainly meaning turbines) total capability of about 1500 HP, which would include high flow capacity[3]. The impression is that something around 1000 HP was the "normal" waterflow expectation for some part of the year, with an additional 50%-75% HP possible during periods of high waterflow.

1) Amesbury Daily News, August 17, 1909, pg. 3
2) Report of the Mass. Commission on Waterways and Public Lands,1918, pg. 221
3) The American Wool & Cotton Reporter Compilation volume for the second half of 1910, edition of September 8, 1910, page 1340.

Max. Horsepower Capability for the Mill Complex, by Year

waterpower, steam power, electric power

Shown is max. rated power for high water flow. Electricity does not add to total power because it is derived in Mills #2 and #6 from their available water and stream power. Hamilton Woolen Co. maximized their power capability, introducing electric power during their last three years mostly from increased waterpower. They would likely not have produced maximum power, but would have minimized the cost of needed power by offsetting steam cost with available Powow water power.



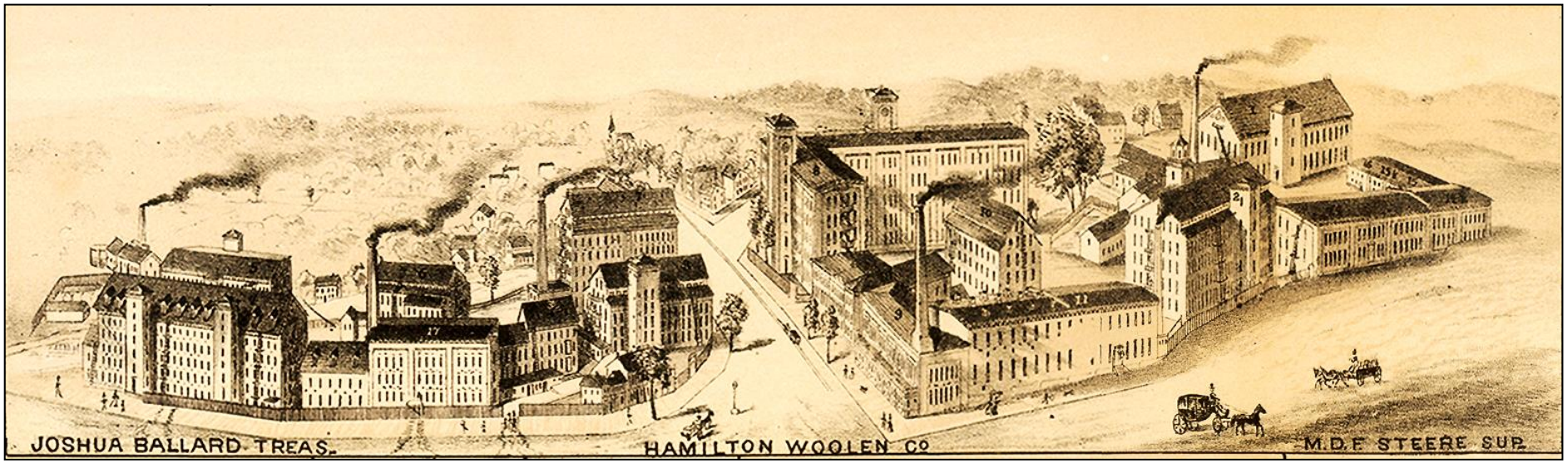
	1862	1878	1882	1885	1889	1894	1904	1908	1909	1916	1918
Water	700	850	950	800	800	800	800	800	1150	1850	1850
Steam	60	400	1350	1250	1250	1250	1250	1250	1750	1850	1850
Electric									800	1800	1800
Sum	**760**	**1250**	**2300**	**2050**	**2050**	**2050**	**2050**	**2050**	**2900**	**3700**	**3700**

Part I

The textile mills and mechanical power

There exists 19th century data regarding total drop heights from each of five dams in the mill district plus technical descriptions of power extraction equipment then in each of the textile mills. However, there has not been found period data regarding a Powow River waterflow rate from which to calculate potential horsepower. An estimate is consequently made based on 20th century data presented in Part II that yields a waterflow of 170 cubic-feet per second for “normal” average long-term conditions.

Powow River Horsepower



Amesbury's Powow River textile mills, from the 1880 aerial map.

All brick buildings adjacent to the Powow River in downtown Amesbury were originally textile mills, most of which derived horsepower from the river (several had no power). The mills reside between Lake Gardner and where Back River joins the Powow along Water Street. No tributaries add or subtract water in that stretch, continuity thus assuring that waterflow leaving Lake Gardner must all arrive at Back River, and that the flowrate is constant throughout the route except as mills draw water for power and then return that water back into the river further downstream. That constant waterflow is the same at each of four main dams (dams 1 & 2 function as a single dam).

An 1872 dam created the Lake Gardner reservoir, allowing the mills to increase their use of water each workday. The lake accumulated water 24 hours per day, as did other ponds in the Powow River system, permitting higher water usage during work hours, or a lessor adequate usage during extended dry spells. Still, droughts some years closed the mills for weeks.

Potential power equals the flow of water through a mill (pounds/second) multiplied by the distance the flow drops (feet) in power extraction devices, typically water wheels or turbines. Such devices are not perfect, so efficiency equals the actual power realized divided by the maximum potential power available. Horsepower sought herein is actual power realized (net yield).

Water Management Considerations

The Powow flows through the mill area in a narrow channel that allows conveniently short dams but creates only small individual ponds above each dam that cannot contain any significant water reserve. (A slight exception is the long channel between Lake Gardner and the first dam.) Flow control gates must thus match mill water consumption to waterflow supply to prevent draining ponds above each dam. Even partially draining a pond would reduce the drop and thus reduce power to the mill. With limited precision of flow control, the mill must error on the slightly low-flow side that maintains a full pond having some “wasted” flow over the dam. Power to the mill thereby remains constant and dependable. (An assumption is that the “waste” flow over dams was the same in 1878 as for the 20th century electrical generation data used.)

Another source of variation occurs at the downstream end of the mill district (Mills 4 & 5) where the Powow is tidal. (Back River is tidal most of the way back to Clark’s Pond.) The critical condition is high tide, during which the discharge arches at both mills are nearly completely under water, possibly reducing available drop from Dam 5 by raising mill discharge level. ,

Also, the relatively large drop of Dam 2 (next page) is a natural feature very near to Dam 1, such that these two are destined to function as a single dam, with the exception that the machine shop is powered by Dam 2 alone.

Discharge arches for Mill #5 (left) and Mill #4 (right) at high tide. Only a few stones of the Mill #4 arch are visible (arrow).

Drop Heights and Mill #2 Power

Drop heights include dam height plus drop in natural terrain between the dam and the mill exit. The Villager newspaper enumerated drop heights during an 1857 economic downturn in which the mill complex was for sale, that data being in the table below. Because Dams 1 and 2 functioned as one, their sum is the important number there. Subsequent descriptions of drop heights on Sanborn insurance maps agree with these. (The 1878 Mill inventory, for which information was shown on the map of mills and dams, was a similar but more complete inventory for the same purpose of selling the mill property.)

The 1857 inventory described mill textile machinery but not power machinery. While large Mill #4 was new and up-to-date, large Mill #2 was not, which new owners soon took steps to correct. New waterwheels were installed and the flume rebuilt, new line shafting of lower friction was installed through the building, and a steam engine was ordered. (The mills had three engines by 1859.) This study suggests herein that by 1878 Mill #2 was still underpowered.

One Mill #2 issue was that its water wheel diameters were less than available drop height. Water could not just be dropped onto wheel from the extra height as the impact and splashing would cause problems. This issue could not be overcome until turbines were introduced. Mill #8 was opened in 1862 with far more waterwheel capacity than in Mill #2, leaving some question as to why turbines were not initially installed in Mill #8.

Dam Heights, Dams 1 & 2 used together

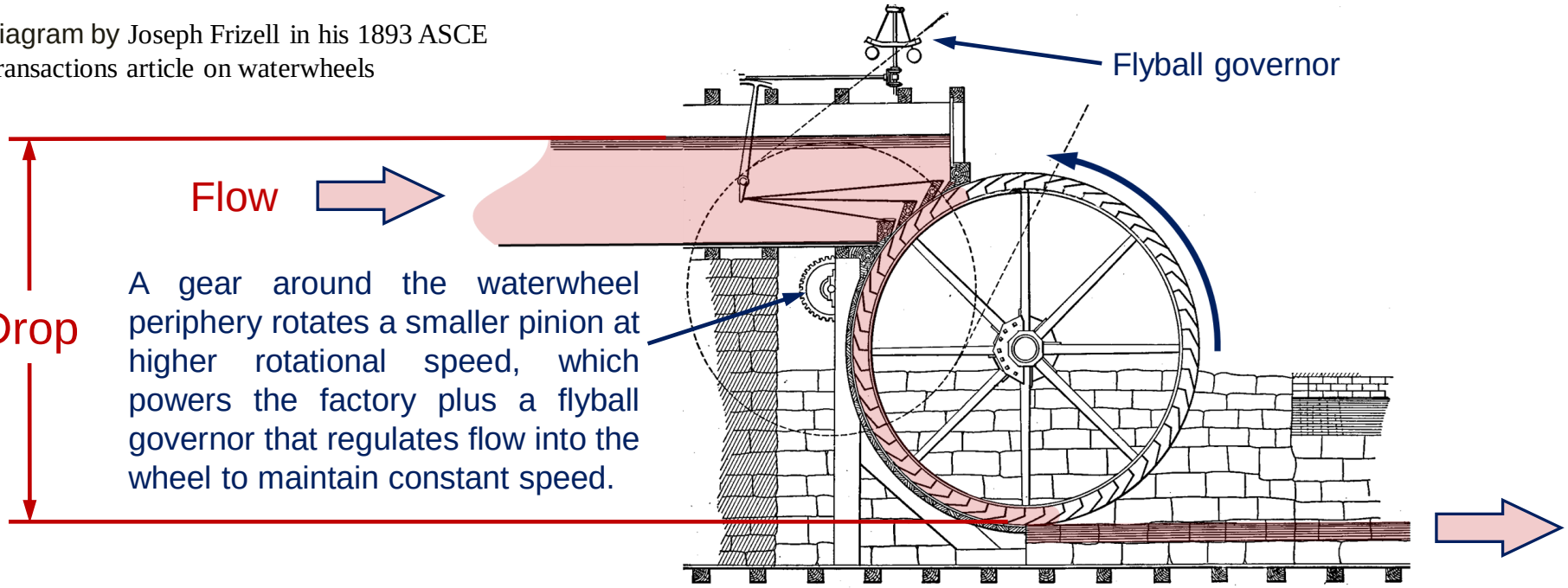
Villager, April 23, 1857, pg 2

	Height			
Dam	Feet	Inches	Decimal	
1	7.00	9.00	7.75	27.33
2	19.00	7.00	19.58	
3	10.00	1.00	10.08	
4	17.00	0.00	17.00	
5	11.00	10.00	11.83	
			66.25	

Typical Breast Wheel Installation

water enters near the top of the wheel, wheel turns CCW

Diagram by Joseph Frizell in his 1893 ASCE Transactions article on waterwheels



Water enters gently near the top of the wheel as a static weight driving rotation. Water exits at (low) wheel-speed, so that little bit of kinetic energy remains uncaptured, in addition to losses from water friction, leakage, and churning in the wheel. Water load is near the wheel rim, and the pinion is directly adjacent to that load to avoid passing forces through the wheel structure and especially through the spokes and to the center shaft. Wheels were wood assemblies operating in damp environments, prone to fatigue and rot that would cause the assembly to become rickety.

Total drop derives from natural terrain plus any upstream dam. Local histories leave uncertain exactly how both are accounted for. Some state that natural drop through town is about 70-75 feet in a series of drops over about 1/8th mile. Dam 1 adds another 7 feet, for a total potential drop of 77-82 feet, leaving about 3 feet average drop between dams that drains wheel exits and maintains rapid river flow, but remains uncaptured for power usage except in the case of Dam 1-2, which uses all drop in the terrain between dams.

Mill #4 Penstock and Dam 5 Sockets

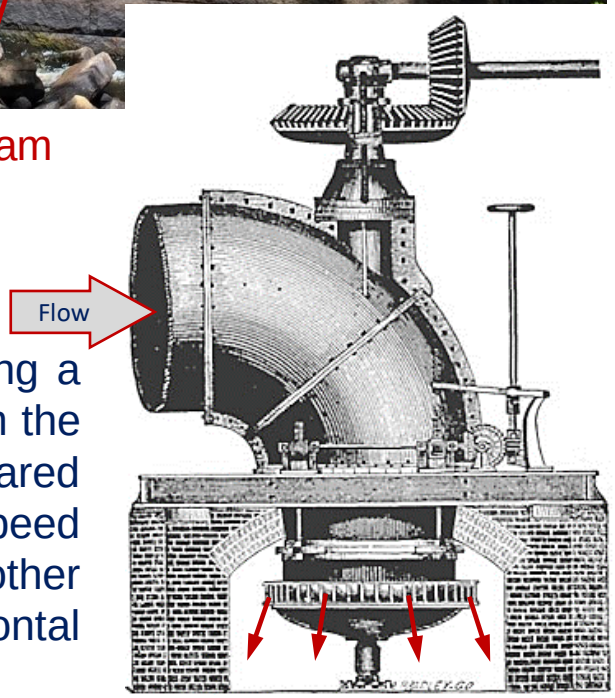
This shows Mill #4 on Water St. viewed from across the Powow River on its Mill St. side. The building is of granite blocks in the area that would have been under water at the penstock entrance into the water turbine (probably originally wheels when built in 1854) and its downstream dam. Sockets in the wall held ends of large cross-beams for the wood crib dam, construction of which can be seen on the next page.

The penstock drew in a large portion of the river flow at a low velocity to avoid losses. Inside the mill was likely a large pool having the same water level as behind the dam. Wheels or turbines could be fed from near the top of the pool, water then dropping to the previously seen river level below the dam at Mill #4 discharge.

There are also dam sockets in the sides of Mill #7 and #3½.

Penstock approx. seven feet in diameter

Sockets for dam cross-beams



Shown is one type of turbine, having a penstock in, and radial flow out from the turbine wheel, plus vertical geared driveshaft stepping up to a higher speed horizontal output shaft. There are other turbine styles, some with horizontal driveshafts.

Example of a Wood Crib Dam, as used in Amesbury

Below shows remains of a wood crib dam in the Chattahoochee River around Columbus, Georgia and Phoenix City, Alabama mill district. (Remains of an older, smaller dam can be seen just upstream of this.) Angled wood beams rest atop posts that are seated on sill beams in the riverbed. The Mill #4 dam would have had similar vertical posts (as well as end support sockets for cross-beams) as can be seen with the Amesbury Dam 1 reconstruction today in the upper mill yard. The angled beams were covered with a solid surface of wood planks to form the dam. The completed dam would have a large vertical water load that would keep it securely pinned down so that it could not move or tip over, while the near-vertical posts prevented sag under the load.

Educational article by Uptown-Columbus, Columbus Georgia

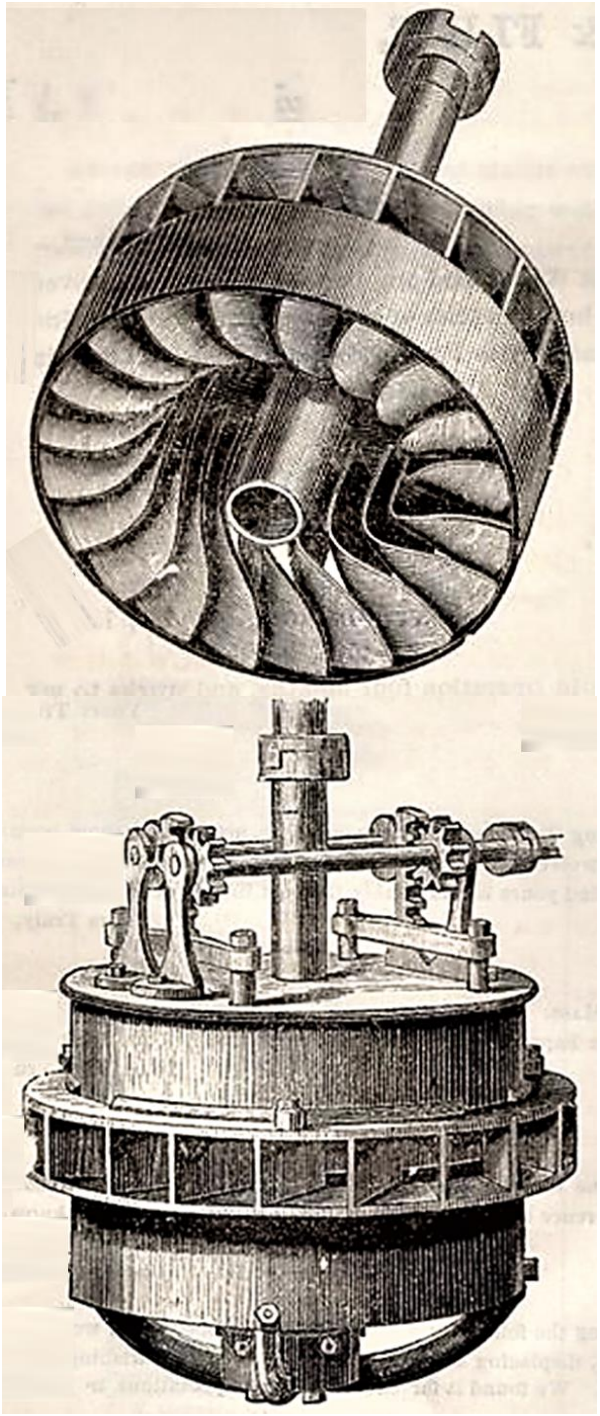
Water Wheels & Turbines in the 1878 Mill Inventory

Three mills still have water wheels in 1878. Mill #2 & #8 water wheels of 25 feet in diameter could not use all 27 feet of available drop from Dam 1-2. (Turbines could use the entire drop and were more efficient) At Dam 1-2, serving Mills #2 and #8, it is assumed that the split (Flow Split Factor) is in proportion to the effective length of their wheel sets, 26 feet for Mill #2 compared to 80 feet for Mill #8. Wheel drop is assumed to be 90% of wheel diameter.

Rodney Hunt Machine Co. of Orange, Mass. and Kilburn-Lincoln Machine Co. of Fall River (in chart below) both made water turbines and textile machinery, and descendants of both still exist. Shown at right is an 1870 Hunt vertical turbine, as might have been used in Amesbury.

1878 Salisbury Mfg. Co. Inventory - Villager, May 23, 1878

Dam #	Drop of Dam	Mill #	Wheel Type	Length	Dia	Effective Length	Wheel Drop
1 & 2	27.33	Mill 2	Breast	6	25	26	22.5
		Mill 2	Breast	20	25		
1 & 2		Mill 8	4 Breast	20	25	80	22.5
3	10.08	Mill 3	Kilburn Turbine Wheel				
3		Mill 7	2 Hunt Turbine Wheels				
4	17.00	Mill 3 1/2	Hunt Turbine Wheel				
4		Mill 6	Breast	18	17	18	15.3
5	11.83	Mill 4	Kilburn Turbine Wheel				
5		Mill 5	Hunt Turbine Wheel				

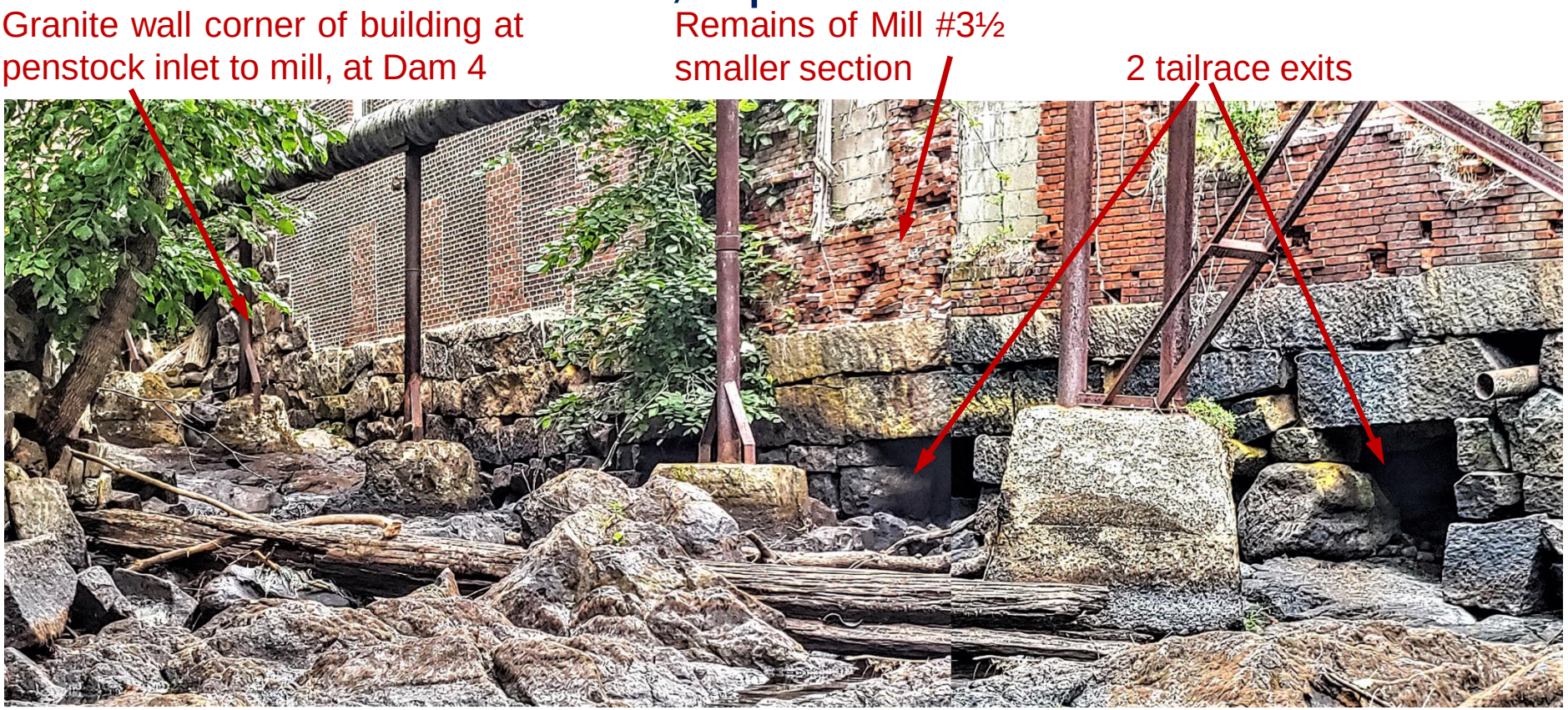


1878 Power Extraction Estimate for Each Mill

The chart below shows power estimates for each mill, there being two mills at each dam, and flow is thus split between them in proportion to the Split Factor (Split Factors for each dam must add to 1.00.) As explained elsewhere, total normal river flow is estimated to be 170 cubic feet per second, which holds up as reasonable. It is assumed that water wheels have an effective drop height equal to 90% of their diameter. Total power yield is about 850 HP, while theoretical maximum for full waterflow is about 1300 HP (at 100% efficiency). Assumed efficiencies for turbines and waterwheels are 80% and 64% respectively. (See Appendix I for details). Mills #2 and #5 seem underpowered, so that actual flow splits may have leaned more in their favor.

		1878 Wheels					1878 Turbines			
		Dia.	Drop	Effic.	Flow Split Factor	HP	Drop (Dam)	Effic.	Flow Split Factor	HP
Mill 2	1 & 2	25	0.90	0.64	0.25	71				
Mill 8	1 & 2	25	0.90	0.64	0.75	217				
Mill 3	3						10.08	0.80	0.40	65
Mill 7	3						10.08	0.80	0.60	97
Mill 3 1/2	4						17.00	0.80	0.30	82
Mill 6	4	17	0.90	0.64	0.70	137				
Mill 4	5						11.83	0.80	0.75	142
Mill 5	5						11.83	0.80	0.25	47
				Wheel HP Sum		425		Turbine HP Sum		432
									Total	857

Tailrace Exits at Mill #3½, Upstream from Dam 5 at Mill #4



Mill #3½ originally had two wings operating as a saw mill and a separate grist mill, which were then merged into a single textile-related company. (the two sections are seen in a later photo). The latter company was purchased by Salisbury Mills Co. in 1863. The mill is off Water Street, where the larger section still exists today, although brick portions above the ground floor have been removed and replaced by wood structure. Seen above are portions of the buildings below ground level, down the embankment to the river. Above-ground portions of the smaller section (brighter red brick portion at right) have been removed altogether and have become a parking area.

Two separate tailraces for the two parts of the mill can be seen, fed by Dam 4, which was up by the granite corner at far left. The top of Dam 5, downstream at Mill #4, is at a lower level than these exits by several feet, so that Dam 5 cannot backwater these exits. Natural river drop likewise protected other mill tailraces from backwater obstruction from downstream dams during high flow.

Part II

Electric Power, from Textile Mills to Public Electric Utility

Compared to the 19th century mechanical period, there is much more 20th century electric generation data from which to understand the Powow River. Modern users were designing for roughly 16 HP per foot of drop during “normal” flow conditions, which for assumed turbine efficiencies of 80% imply waterflow of 170 cubic feet per second. (A 1909 article reported that a Mill #6 turbine could handle 233 cubic feet per second) These numbers are the basis for estimating 19th century power yields at each dam and textile mill.

The Salisbury Mills Company

Approaching full waterpower capacity

The Salisbury Mills Company had purchased the mill complex during a brief recession in 1857. Driven by Civil War demand, they completed in 1862 the last substantial water-powered mill, large Mill #8, in addition to a group of non-powered brick buildings at the top of the upper millyard. During 1863 they purchased the last remaining water privilege along the river (the basis for Mill #3½), after which they owned all water rights and adjacent Powow real estate. Riding out much of the remainder of the 1860s, they embarked around 1870 on a major expansion campaign, likely from a strong cash position accumulated from Civil War profits. They built two large boiler houses, one the long brick frontage in Market Square serving Mills #2 and #8, and the other on Water Street, now Silvaticus Brewery, serving Mill #4. They were replacing older waterwheels with more efficient turbines, although specific dates have not been found beyond those of Mills #3½ and #7 in 1873. A majority of mills clearly had turbines in use by 1876. The other major undertaking was to complete in 1872 the dam that created Lake Gardner, seemingly named after the company Treasurer, as a reservoir that could maintain significant workday waterflow during relatively normal weather.

Salisbury Mills Company had brought the complex to a fairly full use of available waterpower and well represented a legacy mill system from the 3rd quarter of the 19th century. At least in terms of power extraction, a traditional waterpower system had been bolstered and updated with technology changes. That all may have markedly depleted company cash, just as the economy dropped in 1873 into an extended recession that brought the company to ruin in 1876. The mill complex sat unused and for sale for four years, one issue being that the direct textile-related machinery had become obsolete. Amidst this hiatus, the 1878 inventory was published to inform citizens regarding the town's largest industrial asset and employer.

The Hamilton Woolen Company & Mill #6

Hamilton Woolen Company purchased the complex for $300,000 in 1880, followed by two years and $600,000 of extensive modernization. They were an existing company owning a textile mill complex in Southbridge, Massachusetts that operated until 1934.

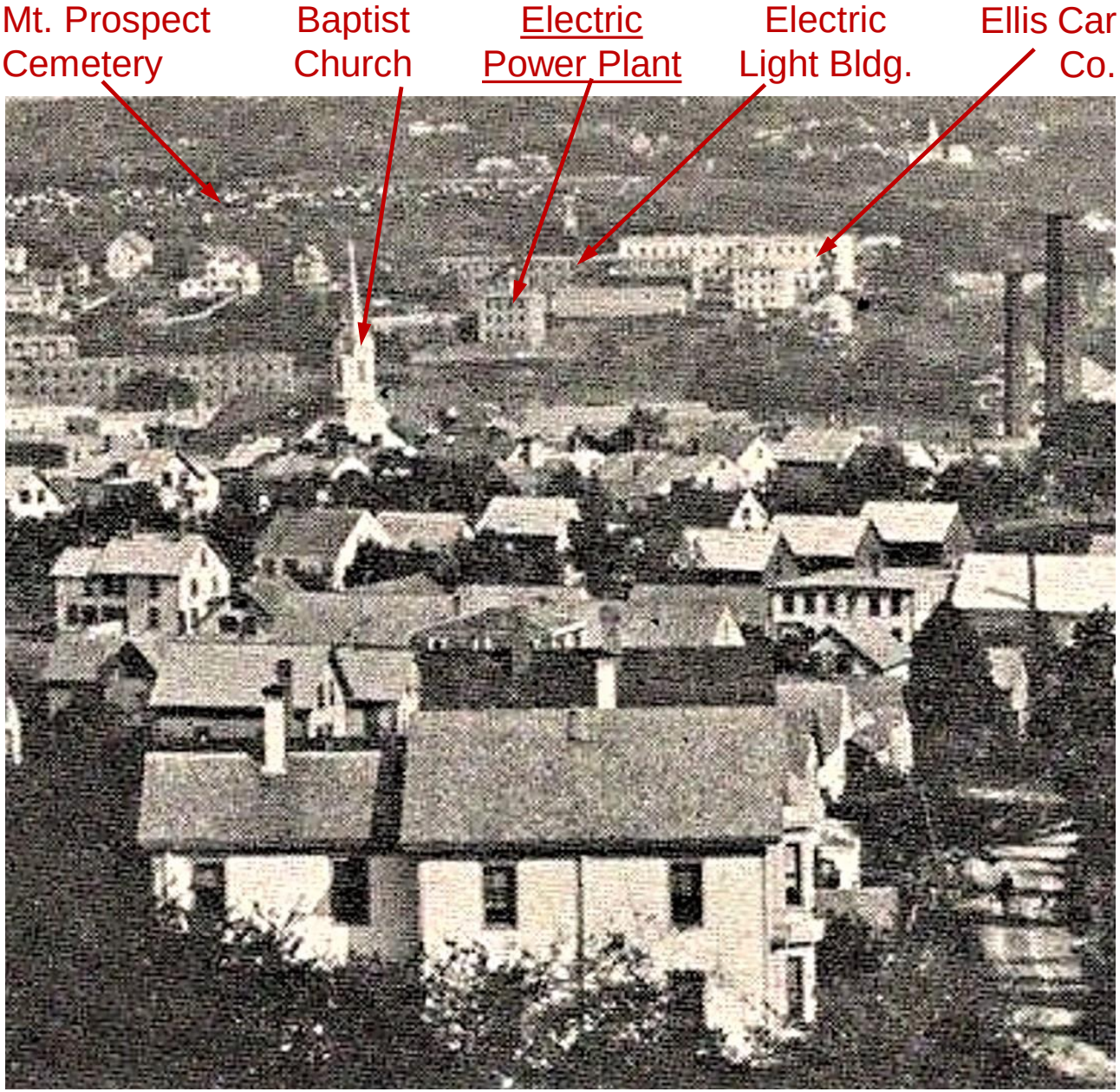
The Powow River yield was approaching about 1000 HP, but waterpower was only part of a balanced system for reliable mill complex operation. Also, Hamilton's modern textile equipment would likely operate at higher speed, implying higher power consumption. The company sought both more horsepower and dependable year-round horsepower. They installed during 1882 (see appendix) new steam engines in Mills #2, #4, and #8, as well as a new water turbine in Mill #2. While historical records are scarce, Mill #8 is known to have received a water turbine that still resides in the concrete foundation of the new building on that location. Mill #4 continued to have both water and steam power. Old Mill #5 had alternate power by connecting across the river to Mill #4 by means of a "belt box", a leather drive belt contained within a wood casing. Likewise, old Mill 3½ was connected by a belt box across the river to the waterwheel house of Mill #6. It appears that Mill #7 continued to have waterpower, but by the 20th century steam engines were approaching 1500 HP, with the mills able to operate using little waterpower. Overall, Hamilton reduced mill complex dependence on a somewhat fickle flow of the Powow River, too often punctuated by high-flow wet seasons and contrasting droughts.

Regarding several of the mill buildings, Mill #6 was the oldest, its core dating from 1812 but it had since been enlarged. The second oldest was Mill #5, right below Mill #6, having been built in 1813. Both these old mills continued to operate under Hamilton ownership. In contrast, the third oldest mill, Mill #3 built in 1820, was immediately retired by Hamilton Woolen Co. and never again functioned as a textile mill. It was converted to retail storefront space (the mills owned most commercial properties along the first block of Main Street) and was reduced down to two stories during the 1890s. Ben's Uniforms now occupies the remains of Mill #3. An attractive feature of Mill #6 was that it was powered by Dam 4 that, at 17 feet of drop because of natural terrain, offered the second highest drop along the river for producing waterpower.

Amesbury's First Electric Power Utility

The first Amesbury electric power utility opened in 1887 at the bottom of Oak Street, part of the complex that was fully opened in 1889 by carriage maker, Wm. G. Ellis, upper-center at right. Ellis made trolley cars in the large white wooden building, which burned in 1893.

The long brick building, known as the "Electric Light Building", was an industrial condominium, functioning today as residential condominiums next to the rail trail. The coal-fired electric plant powered the complex as well as electric street lighting in town and the Folger & Drummond carriage factory. Electricity was also sold domestically through the Amesbury Electric Light Company. The power-plant was expanded ca. 1903, but likely never exceeded one thousand horsepower.



The near house is #49 Powow St, looking southeast, ca. 1890

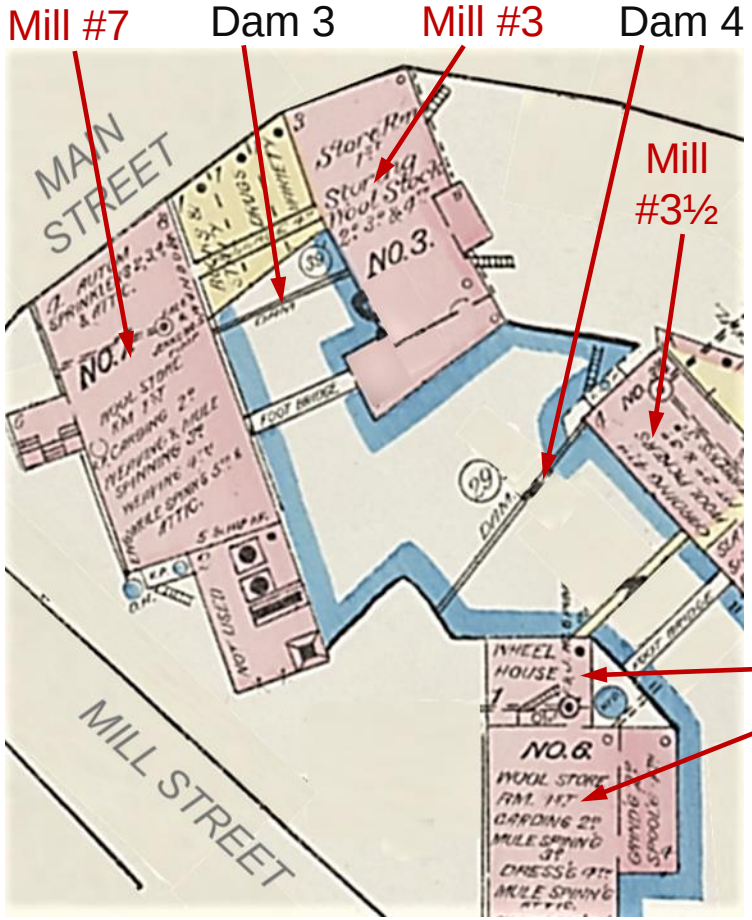
Mill Power Usage

Ellis's electric power plant had come a decade after Edison invented the light bulb. The original purpose of electric power was to drive out darkness, steam-powered generator systems being installed in individual factories for lighting. Electric dynamos essentially could also be electric motors, so that the Electric Light Building and Folger & Drummond factories likely used relatively large electric motors to power traditional line shafting and leather belt drives to each machine. Already noted is that such shafting and belt systems themselves consumed some of the power. Time was required for a) electric power to become widespread, b) the idea of individual motors for individual machines to create demand for such motor sizes, and c) more machinery makers to design their machines around such motors. Especially with a major depression during the 1890s, it was more like the turn of the century for the modern electric factory to evolve.

There was still no electric power in Amesbury's textile mills after 1900, when the mills were managed by an Irish immigrant named Michael W. Quinn. Quinn's son, Frederick J. Quinn (1874-1950), had become, at a young age, manager of a textile mill in Petersburg, Virginia. When Michael Quinn died in 1906, Hamilton Woolen Co. hired his son, then age 28, to manage the Amesbury facility. He proved to have an interesting vision, majorly modifying mill complex power generation and distribution with a blend of waterpower, steam, and electricity. The reality was that there was no external power grid or other electricity source other than the Oak St. powerhouse, and the textile mills did install 1200 electric lights in 1908 that necessarily had to be powered from there. Amesbury was an electrically isolated island, within which the mills had to become their own electrically isolated island. This required making best use of resources, irrespective of current power systems, including the ease with which electric power could be transmitted through wires rather than through mechanical shafts and belts.

While the mills became capable of operating on steam alone, and were reported in 1909 as doing so, efficiency resided in fully using water rights already owned to avoid the cost of steam fuel. The mills thus likely maintained their waterpower even as they expanded their steam capacity. This also would have enhanced the value of the property.

1909 Conversion at Mill #6 to Hydro-Electric Power



1885 Sanborn Map, sheet 3

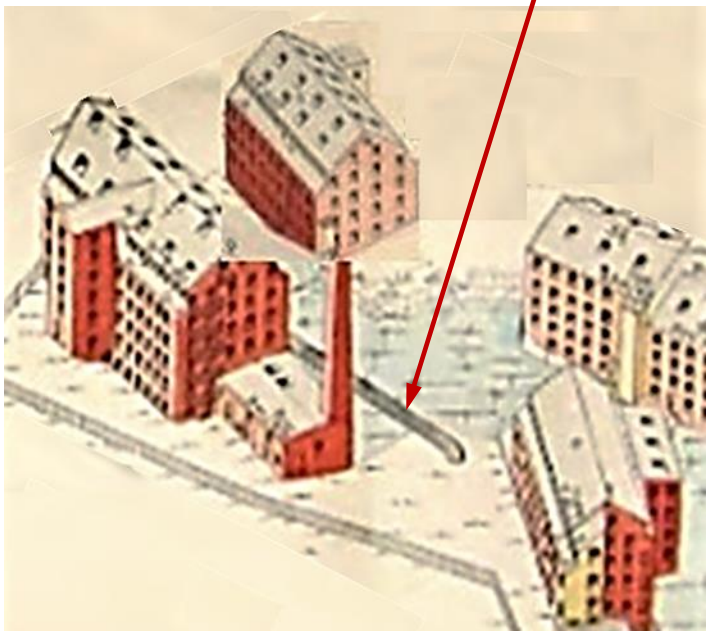
A (water)-wheel house was located at the upstream end of Mill #6, fed by Dam 4. Mill #7 had been used mainly for wool work, which ceased in 1887, closing its steam powerhouse. Mill #3 had become rented retail space and had since been sold. Mill #6 and small Mill #3½ had both done wool work, and had since become storage space. (Post-wool Mill #6 had been leased to carriage related businesses, but with carriage making decline during the 1890s depression, had became unused.) The first two floors of Mill #7 still performed cotton weaving (but the mill was vacant above), being the only use of power from Dams 3 and 4, having 10 and 17 feet of drop respectively.

Wheel House

Mill #6

To recover this wasted waterflow, Dam 3 was rebuilt in concrete during 1909 to the maximum height that would fit under the Arcade Building that was over the river between Mills #7 and #3. This dam was connected to the Mill #6 wheel house by an 8½-foot-diameter penstock, creating a 29-foot drop. The wheelhouse was fitted with a 500 HP turbine-generator using the full river flow. The steel–pipe penstock shows at right in a 1910 isometric insurance map.

Penstock connecting new Dam 3 to Mill #6 wheel house.



Map of Associated Mutual Ins. Cos. 12/15/1910

F. J. Quinn's 1909 Re-arrangement of Textile Mill Power

Major changes under Frederick J. Quinn occurred in 1909. It is difficult to surmise his perception of things. The mills had been declining, with 40% of mill space having been non-productively vacant for over a decade. He perhaps blended a cynical inkling of the future with a view of alternate possibilities, but his ideas would have had to have been folded into a compelling business plan to improve operating efficiency for the Hamilton Woolen Company.

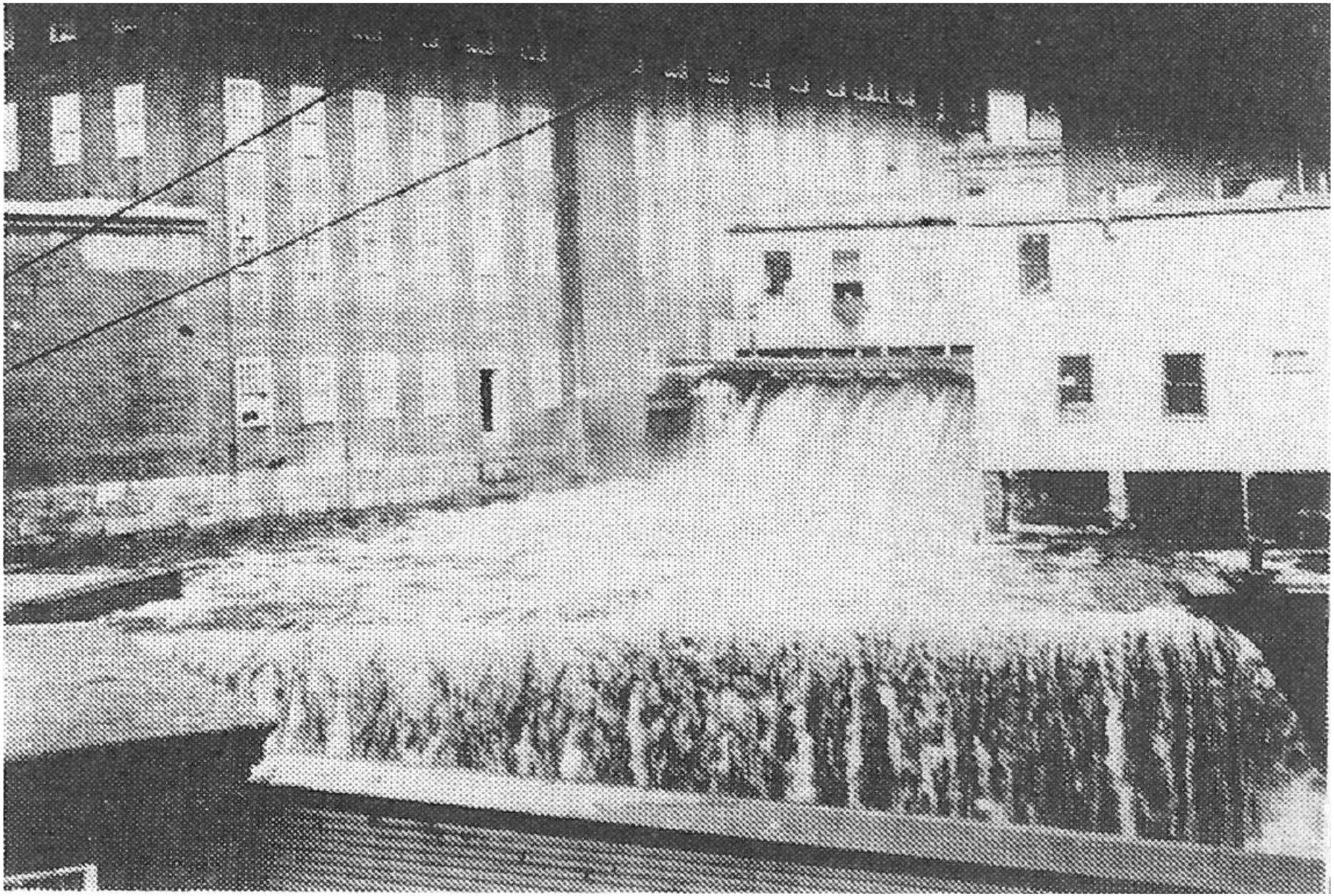
Mill #2 powerhouse (Flatbread Pizza) received a new 800 HP steam engine in the spring of 1909, and a 300 HP generator in the fall that ran off the engine. If needed, this generator could supply electric power to Mills #7 or #4, as well as to Mill #2, while the remaining 500 HP was transmitted mechanically to Mill #2. Also in the fall, the Mill #6 hydro-electric station (previous page) was completed, supplying 100 HP to Mill #7 and 400 HP to Mill #4 on Water Street. Electric power was utilized at these mills in the form of electric motors on each floor driving existing shafting. The Mill #4 boiler house (Sylvaticus Brewery) had been running continuously, but was now planned to be idle for about eight months of the year, and then to supply steam heat to the mills during winter (the insulated steam pipe still seen along the Powow River).

The main boiler house (the long brick frontage in Market Square) was upgraded to run the new Mill #2 engine plus a new Mill #8 steam engine of 900 HP. According to a 1910 description, the latter consisted of two existing Greene engines that had operated together, joined to a new low-pressure engine, having a large diameter piston, running on their exhaust in what was typically called a cross-compound engine. Steam was thus used twice in series through the engines for a more complete expansion. It was stated in late 1909 that Quinn planned on installing a hydro-electric plant at Lake Gardner several years hence. The net result of these changes was savings in boiler fuel, aided by electric power from the Mill #6 hydro-electric plant and flexibility in efficiently managing electric power by switching it between mills.

Mill #6 was demolished in May of 1912, followed closely by the textile mills closing permanently in August of 1912, a seemingly coordinated move that put about 700 people out of work. After 100 years of textile manufacture, the Powow River was prepared for its next phase of life.

Dam 3, Between Mills #7 (left) & #3 (right)

Water flows under the Arcade Building and over Dam 3, which was then a raised concrete dam supplying water to a turbine at the Mill #6 waterwheel room. Exact date of this photo is unknown.



Vintage image of unknown date from 1980s mill yard walking-tour guide

Amesbury Electric Light Co.[1] and MVP&BCo.

The mill complex sat dormant for several years while organizational creations and changes shaped a new structure. It is unclear how much had already been evolving and/or how much involved principals of the former Hamilton Woolen Company, but at least Frederick J. Quinn was included. Driving out darkness remained the compelling force pushing expansion of domestic electric power and implying major investment opportunities. While W. G. Ellis had since passed, his Amesbury Electric Light Co. was an enduring corporate entity that reorganized in 1906, then enlarging its powerplant and expanding its service area throughout town, such as to the 1910 municipal water pumping station on Newton Road. Between this electric utility company and generating capacity of the now-available textile complex, Amesbury Electric Light Co. caught the attention of the Boston financial house of Chauncey D. Parker & Company, which bought a majority interest in 1913. The new investors placed one of their managing partners, Bowen Tufts, on the Board, from where they influenced coming decades of Powow River waterpower.

The Merrimack Valley Power & Buildings Co. was incorporated in June 1915 with an authorized capital of $400,000 and Frederick J. Quinn as President. The Boston engineering firm of Charles T. Main Co. was commissioned to design and manage 1916 construction of Quinn's long-envisioned dam and turbine building at Lake Gardner, plus a hydro-electric house and control center at the old Mill #6 site, immediately adjacent to Quinn's 1909, 500 HP hydro-electric plant.

Reports of the Lake Gardner facility cited various rated powers from 220 to 800 HP from a drop of 16 to 20 feet. Having about 25% of the drop available in the mill district, a quick surmise is that it had about 25% of the mill district power (1000 HP), for 250 HP. The plan for the new facility at the Mill #6 site was to utilize the entire drop through the mill district to achieve 1000 HP, while leaving intact the 1909 system for generating electricity in Mill #2; there would be two systems in parallel[2]. Dams 1 and 2 (working as a single entity) would remain, along with the new concrete Dam 3 serving the 500 HP unit. Dam 5 would be removed but Dam 4 apparently stayed.

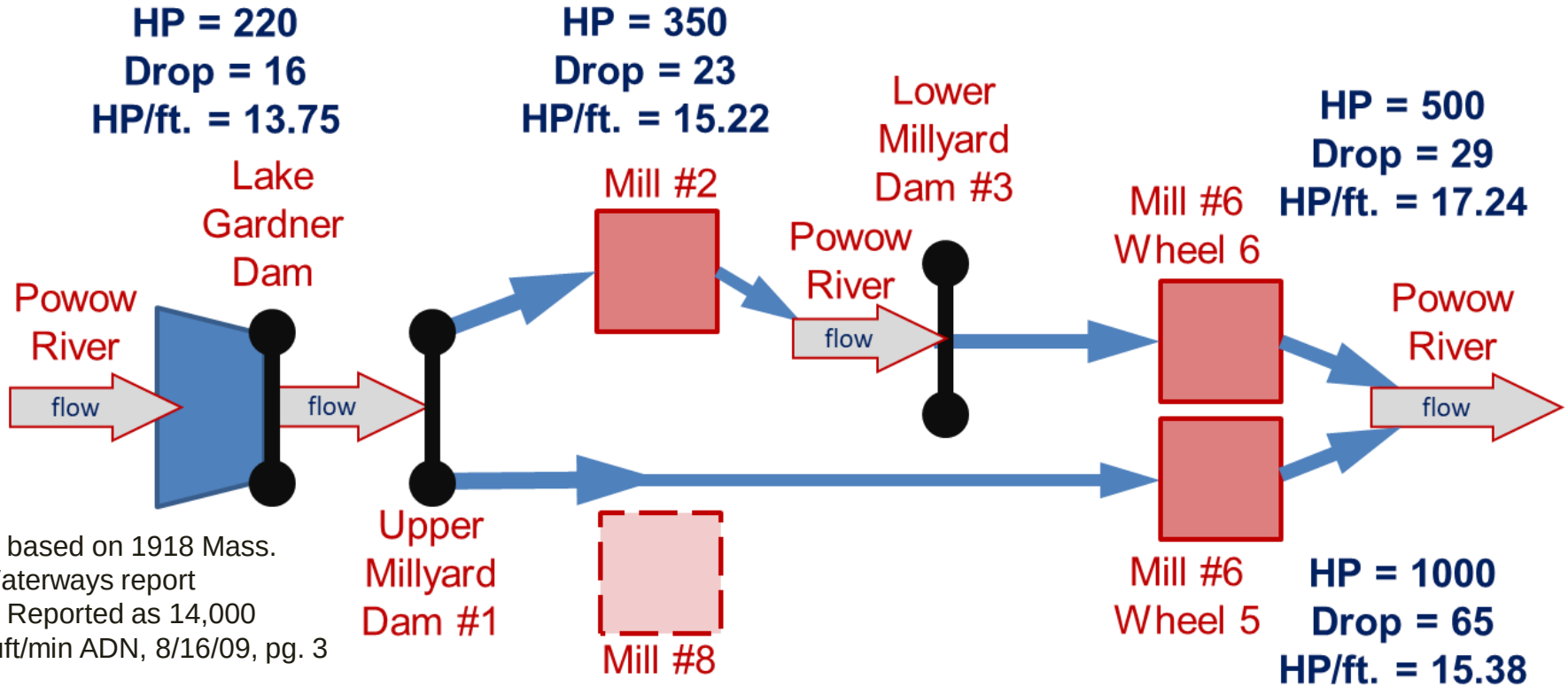
1) Drawn largely from *Amesbury's Industrial History – A View From the Millyard*, Gray Fitzsimons & John Mayer, ACM, 2018, pg. 12
2) Report of the Mass. Commission on Waterways and Public Lands,1918, pg. 221

Schematic for 1916 Hydro-Electric Generating System

with two parallel branches flowing through the mill district[1]

Two independent branches began at Dam 1 in the upper millyard. The large Mill #8 brick penstock was wholly fed into a new 6-foot diameter brick penstock down to the new Mill #6 1000 HP turbine-generator set. This branch ran continuously in series with the new Lake Gardner plant for a rated sum of 1220 HP during normal periods. In times of excess flow, the Mill #2 generating plant also worked in series with the Mill #6 500 HP turbine to yield an additional rated sum of 850 HP, for a system total of 2070 HP. All plants were controlled electrically from the Mill #6 plant on Mill Street, with no personnel required at Lake Gardner.

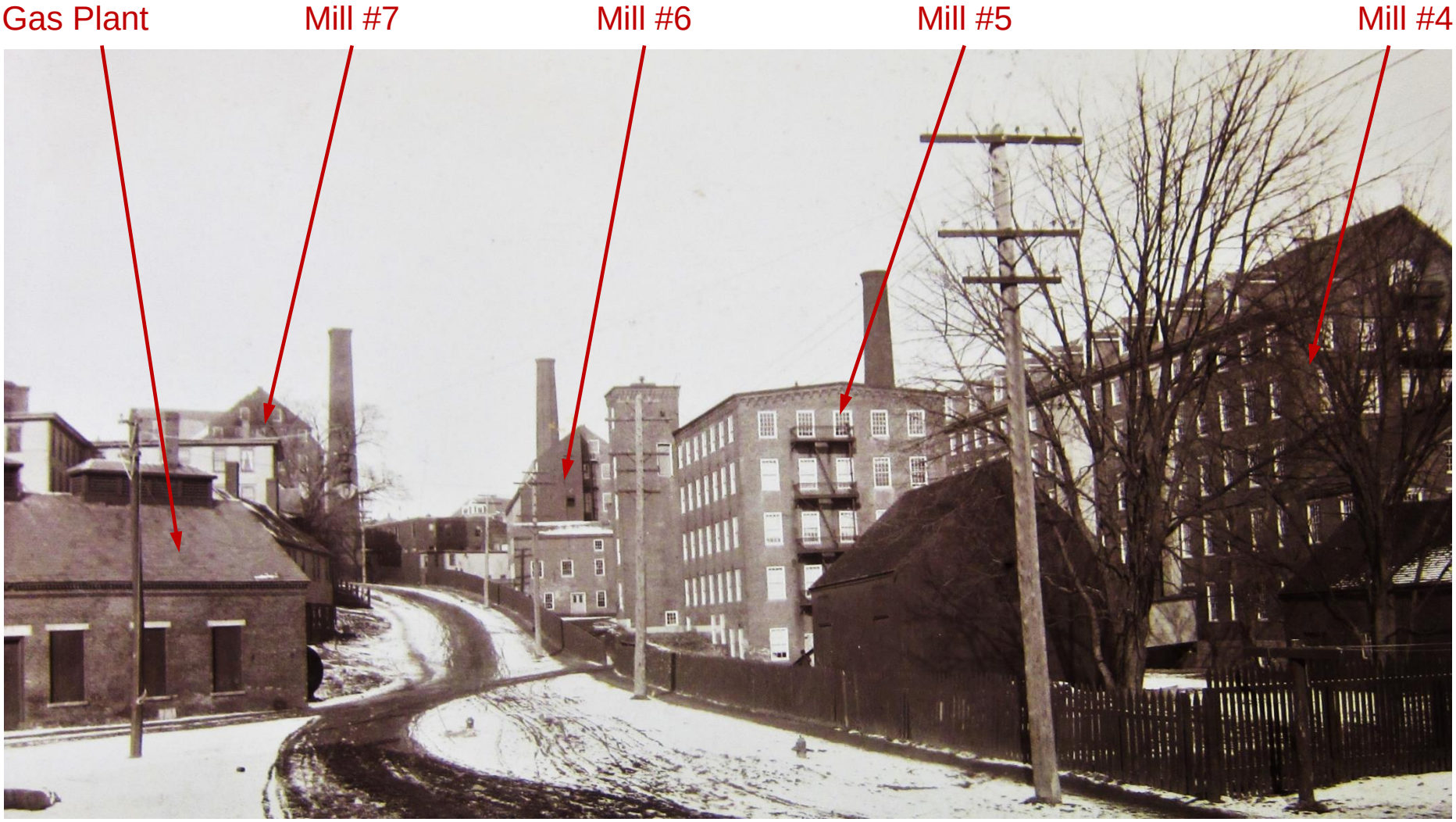
Three mill district turbines averaged 16 HP per foot of drop, implying 170 cubic feet per second of waterflow (assuming turbine efficiencies of 80%), noting that this is their maximum continuous design potential, separate from actual usage. Reported in 1909 was that the 500 HP Mill #6 turbines could handle 233 Cu. Ft. per second[2] of waterflow.



1) based on 1918 Mass. Waterways report
2) Reported as 14,000 cuft/min ADN, 8/16/09, pg. 3

Looking Up Mill Street, ca. 1900

This view of Mill Street is nearly unrecognizable today, showing Mill #6, which was demolished in 1912 and then replaced by a hydro-electric generating plant in 1916, next four pages.



Mill #6 was demolished in 1912 to make way for the incoming Merrimack Valley Power and Buildings Company, which was officially organized in 1915. That organization functioned as electric utility and real estate company leasing powered industrial condominium space in the former mill buildings. Mills #5 and #6 plus the gas plant building are now gone. Mill #7 has been reduced in height and its powerhouse and smokestack removed.

Looking Up-River at New 1916 Hydro-Electric Plant

Mill #5 front left, Mill #4 front right

A new building resides over new concrete turbine rooms at the Mill #6 location, with transformer station just forward of there, where it remains today.

Dam 5 at Mill #4 has been removed here, and the riverbed blasted deeper upstream to the new turbine water discharge, so that turbines receive full drop. A concrete divider turns discharge flow downstream and separates it from river flow coming down the channel behind it. The Mill #6 turbine building is gone today but the concrete rectangular discharge and divider can still be seen.

Little remains of Mill #3½, making this picture difficult to recognize, next pages.

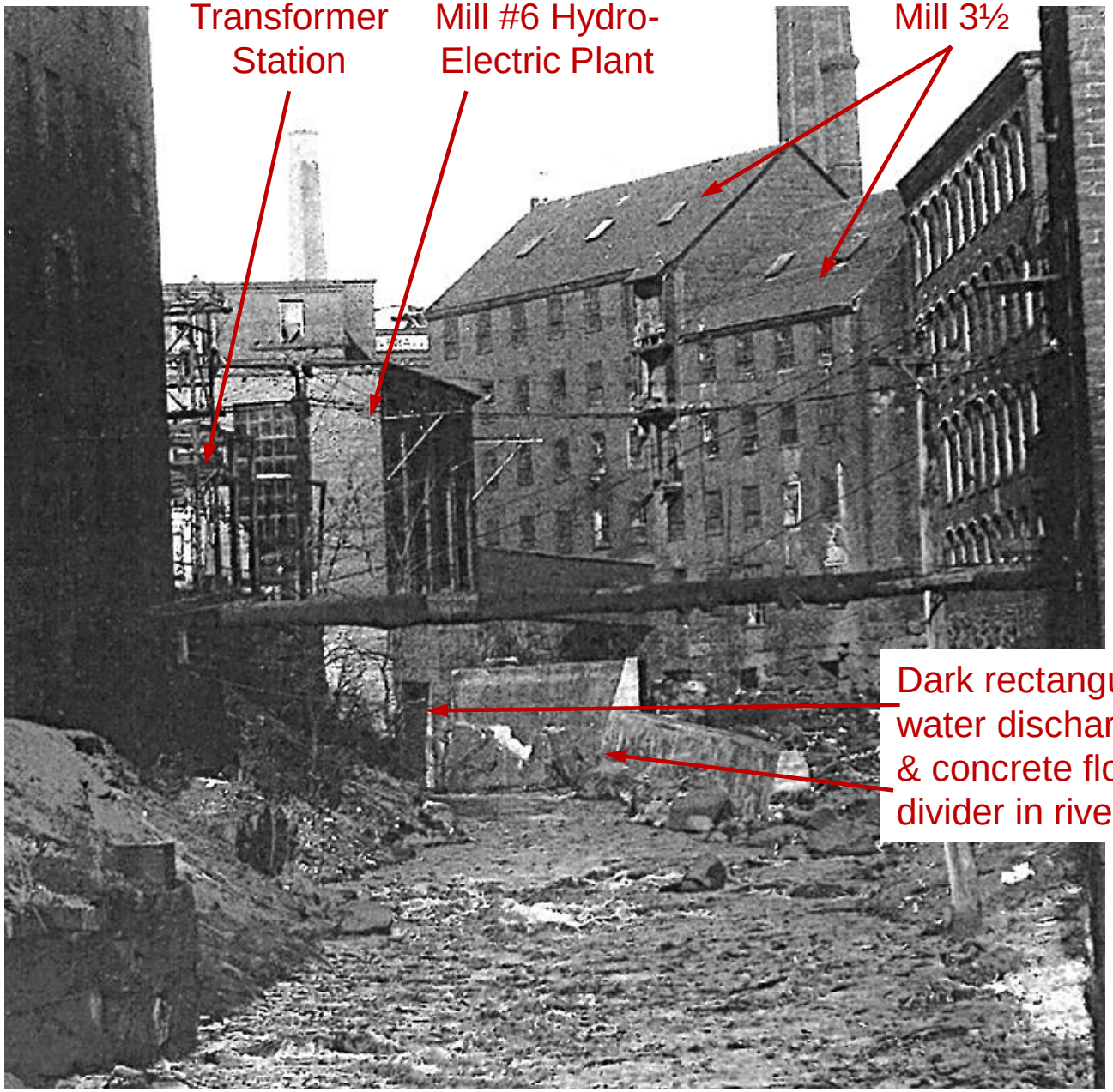


Photo courtesy APL

Merrimack Valley Power and Buildings Company

To achieve full drop at the new hydro-electric plant, Dam 5 was removed and the riverbed on the Mill #6 side dynamited deeper up to the hydro plant discharge[1], also increasing drop for the older 500 HP unit. A concrete divider wall was added to smoothly turn turbine discharge downstream and shield it from being impeded by the river flowing downstream from above[1]. Frederick Quinn seemingly remained involved through construction, but departed immediately thereafter, when Boston lawyer and real estate speculator, Fred L. Hewitt, became President of MVP&BC. Merrimack Valley Power & Buildings Co. leased mill complex factories to industrial tenants, sold electricity, and maintained many of the housing tenements in the Mill Street to Aubin Street area. Several factories along Water St. were sold to a new entity called Amesbury Associates (of which Fredrick Quinn was a principal), being the Mill #4 powerhouse (Silvaticus Brewery), Mill #17 (now Artists' Muse), and Mill #3½ (recently Cameron Office Products).

While gone, Frederick Quinn continued to have some Amesbury presence. He had joined with a Joseph G. Phelan in a group of ventures selling used textile machinery from Hamilton Woolen Co. and others and began an enterprise spinning yarn with some of the equipment for use in rubber tires. As shown on the 1918 Sanborn maps, they considered taking space in Mill #4, but seem to have shifted focus to New Bedford and Charlotte, North Carolina selling used textile equipment to expanding southern mills[2].

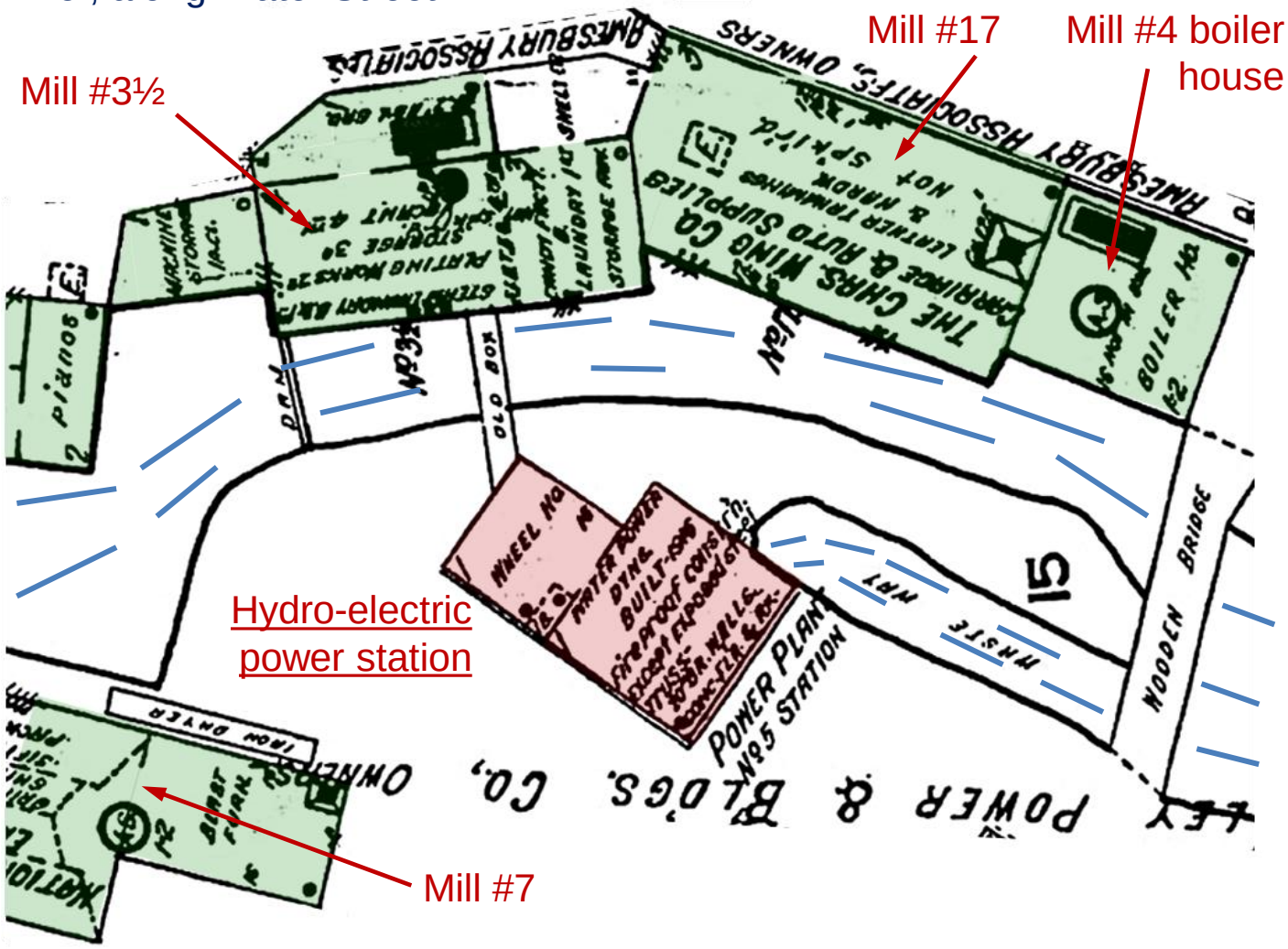
MVP&BCo. had a reported 2000 HP of boiler capacity[3] and we can account for about that in rated steam engine power to use it. A generator had been placed in Mill #11, adjacent to Mill #2 powerhouse, running off that engine. Amesbury Electric Light Co. contracted for electricity from Merrimack Valley Power & Buildings Co. and consequently closed the Oak St. generating plant (shown unused on 1918 Sanborn maps). That plant would likely have required considerable capital investment to make it both larger and more efficient, while the above arrangement offered the use of modern new equipment reaping the electrical output of Powow River waterflow.

1) Amesbury Daily News, August 29, 1916, pg. 2, and December 4, 1916, pg. 2
2) *Amesbury's Industrial History – A View From the Millyard*, Gray Fitzsimons & John Mayer, ACM, 2018, pg. 10
3) Report of the Mass. Commission on Waterways and Public Lands,1918, pg. 221

The Complete New Mill #6 New Hydro-Electric Plants

Hydro-Electric plant & adjacent mills, 1918 Sanborn Map, Sht. 7

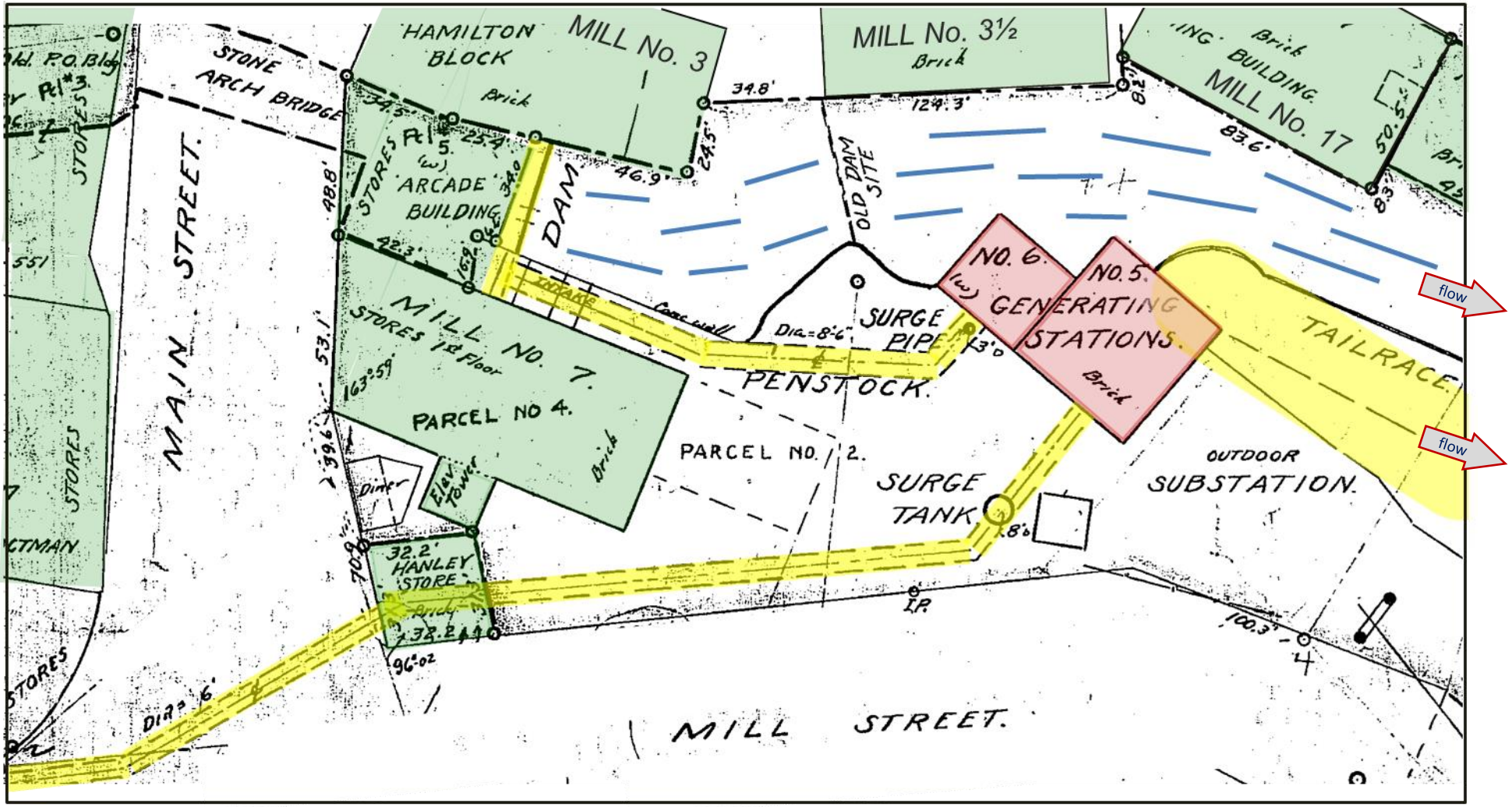
The hydro-electric plant consists of two separate turbine generator sets having separate wheel houses and water supplies (next page). Dam 4 is still shown at Mill #3½ and may have continued to exist. The textile companies had built mill #17 but since 1882 had leased two floors of it to Charles Wing, purveyor of carriage hardware and then auto body hardware. Mill #4 boiler house is now Silvatics Brewery. Amesbury Associates owns buildings on the northeast side of the river, along Water Street.



Mill Races for 1916 Hydro-Electric Plant at Mill #6 Location

hydro-electric plant races in yellow, New England Power Ass'n. map, 12/29/1936

Below shows the short penstock (125 feet) from Dam 3 to the 500 HP turbine at the original Mill #6 wheel room location (upper of the two). Lower of the two is the long brick penstock to the new 1000 HP station erected at what was previously the northwest end of original Mill #6. That was a two-story tall brick building that has since been removed and replaced by a transformer farm.



Looking Down-River at Hydro-Electric Plant, 1928

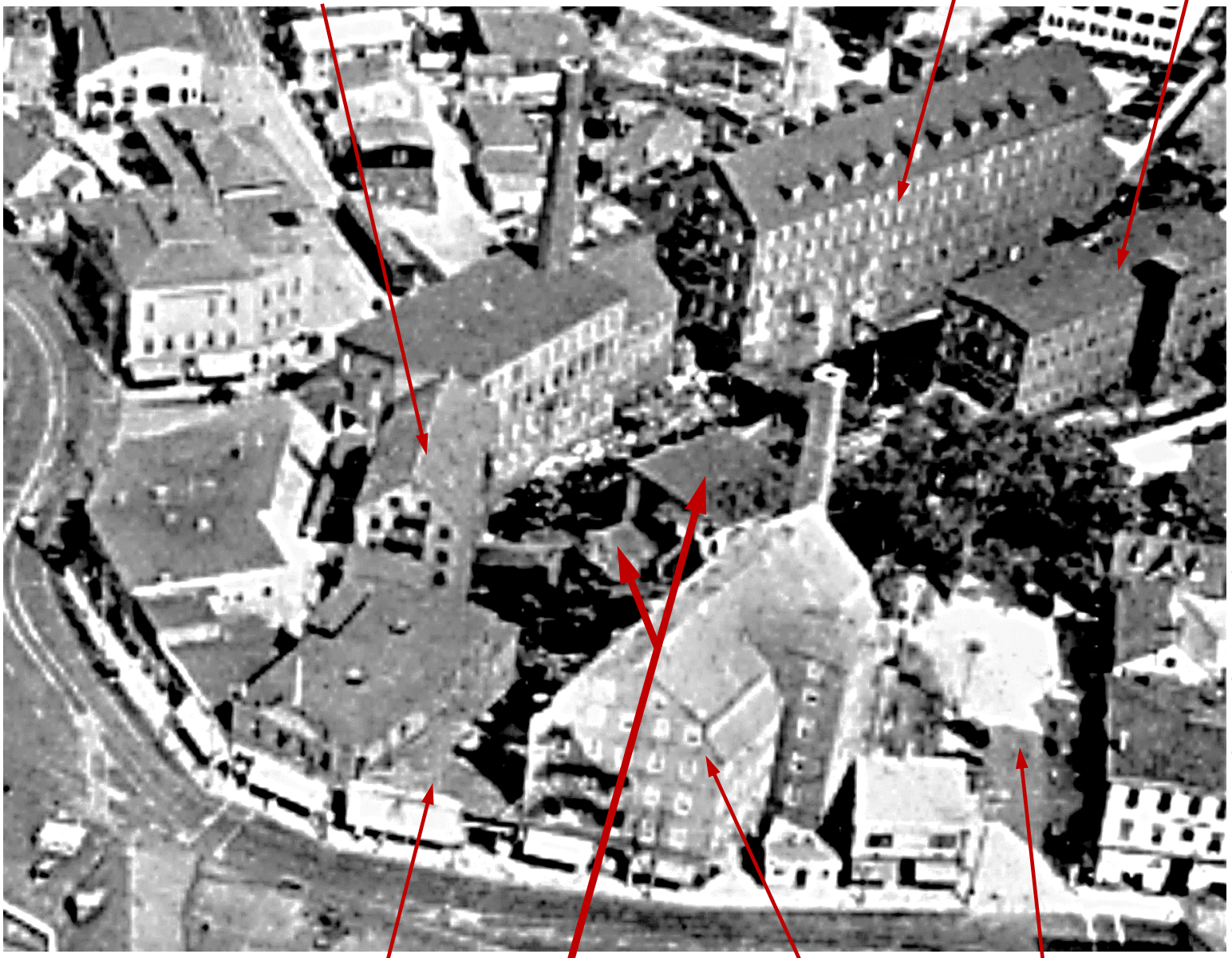


Photo courtesy of Amesbury Carriage Museum

Operation of the MVP&BCo. Electric Utility

1918 Sanborn maps show the mill complex industrial space as nearly fully occupied. Additional income resulted from renting domestic units in the mill housing area of Mill to Aubin Streets, and from selling electricity. While terms of industrial leases are not known, tenants would have had varying needs for heat, electricity, and mechanical power, which would have been billed on a usage basis. Their main electricity customer of Amesbury Electric Light Co. (AEL) would also have had a range of customers having differing consumptions, charged at differing rates.

An interesting twist is that MVP&BCo. was also connected to the Newburyport Gas and Electric Light Co. by a 5½ mile long transmission line capable of carrying 2000 KW[1] (2682 HP). It is not known what this relationship was or which direction the electricity flowed, possibly being a mutual benefit arrangement to manage total load capacity.

A George W. Wood took charge of MVP&BCo. in 1927[1], a Lynn native who had last been manager of Mansfield's municipal electric plant. In 1927 the town charged MVP&BCo. and AEL of colluding to charge higher rates to domestic and commercial users than to its industrial tenants[2]. The town's star witness showed that Amesbury rates were 50% higher than in Newburyport, that price gouging was for the benefit of Chauncey D. Parker & Co. (majority owner of AEL), and that the two companies had "practically the same board of directors".

Chauncey Parker bundled AEL into his 1928 Mass. Utilities Association. Disaster struck in 1935 when Parker and Bowen Tufts, Parker's partner on the AEL board, were implicated in stock fraud. Tufts committed suicide while Parker retired to contest his legal woes. With a few changes, AEL became controlled by the New England Power Association, in the ownership and regulatory evolution of utility monopolies. MVP&BCo. began liquidating assets during the 1932 pit of the depression. George Wood left to lead one of the major tenants, Commonwealth Supplies Co.. Commonwealth and Bailey Mfg. Co. (car window channels) carried many of the millyard buildings through to mid-20th-century. AEL purchased the Powow River water rights, so that the water rights remain controled within in the electricity utility realm.

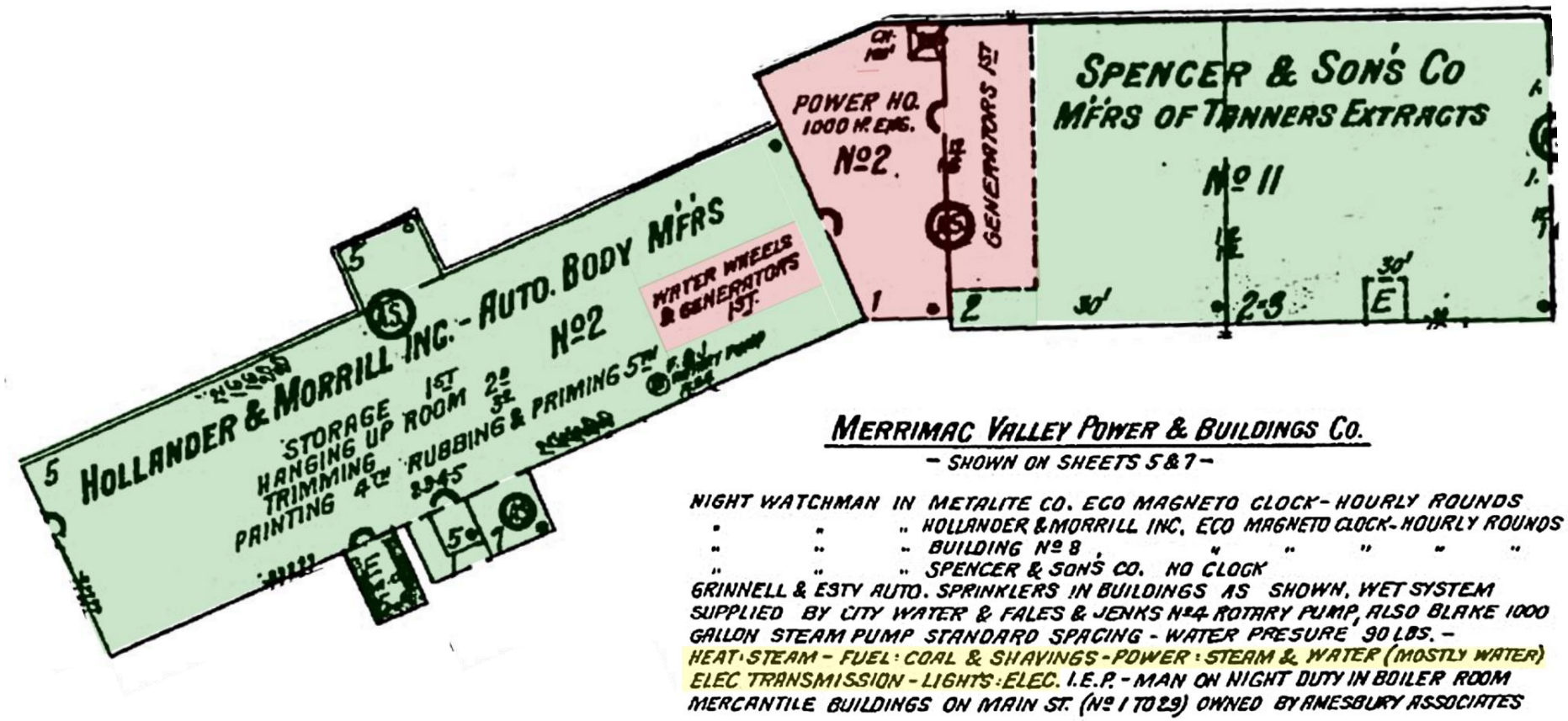
1) Report of the Mass. Commission on Waterways and Public Lands,1918, pg. 221

2) Amesbury's Industrial History – A View From the Millyard, Gray Fitzsimons & John Mayer, ACM, 2018, pg. 10

The Upper Mill Yard Electric Generating Plant

Mills #2 & #11 water wheels, steam engine, & generators, 1918 Sanborn Map, Sht. 5

The old Mill #2 boiler house (now Flatbread Pizza) resides between Mill #2 (left) and Mill #11 (right). Hamilton Woolen Mills installed in it a 200 HP steam engine plus a new Mill #2 water turbine in 1882, steam being supplied from the main boiler house in Market Square. In 1909 they installed a new 800 HP engine, at which point it is unclear if the two engines operated together. Sanborn maps show the power house as producing 1000 HP, while period newspaper articles discuss the 800 HP engine. A 300 HP electric generator was placed into Mill #2 at that same time (1909). It appears that Merrimack Valley Power & Buildings Co. placed generators into Mill #11. Mill #2 also has generators (plural), as well as water wheels, certainly meaning turbines.

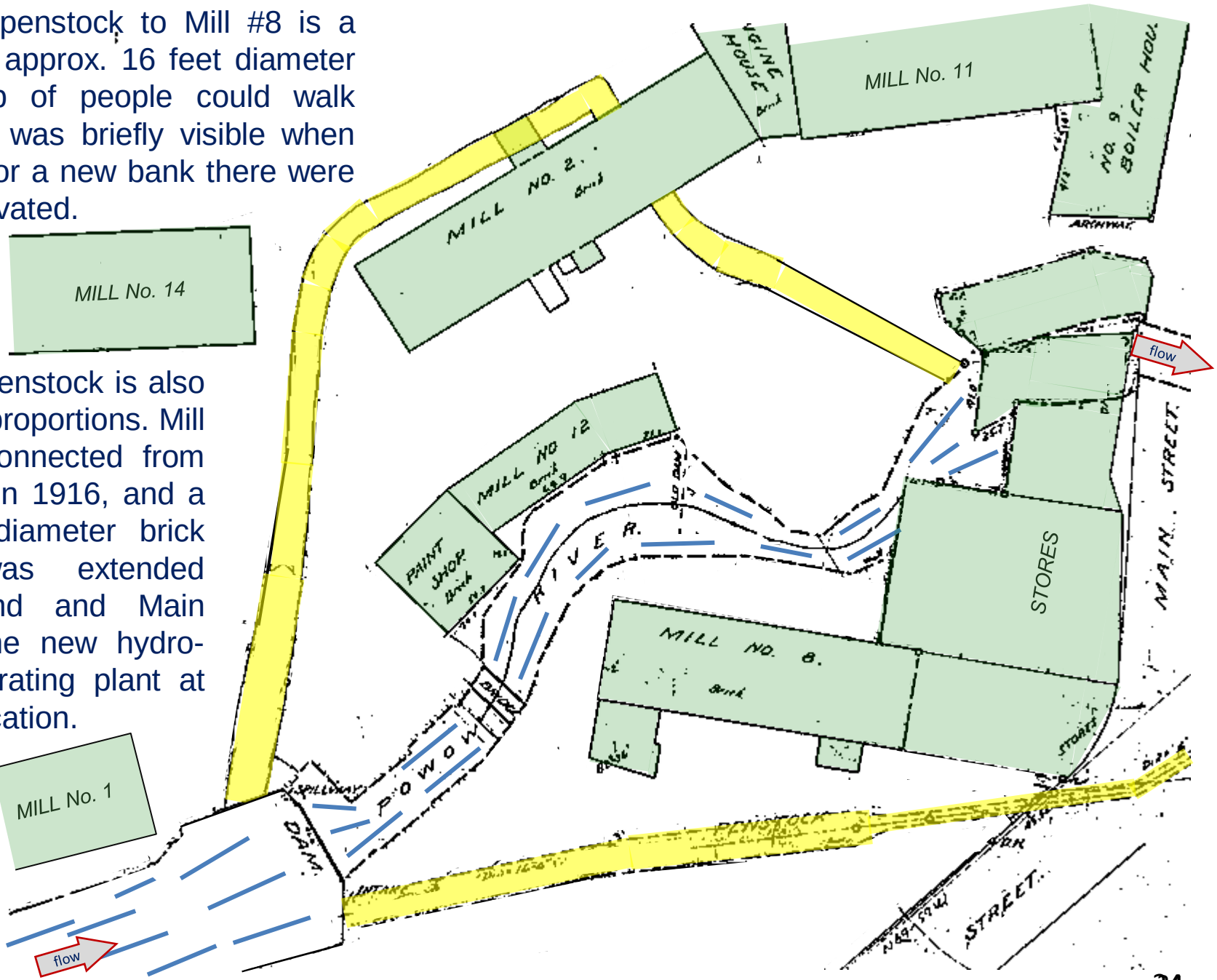


1916 Mill Races for Mills #2 & #8

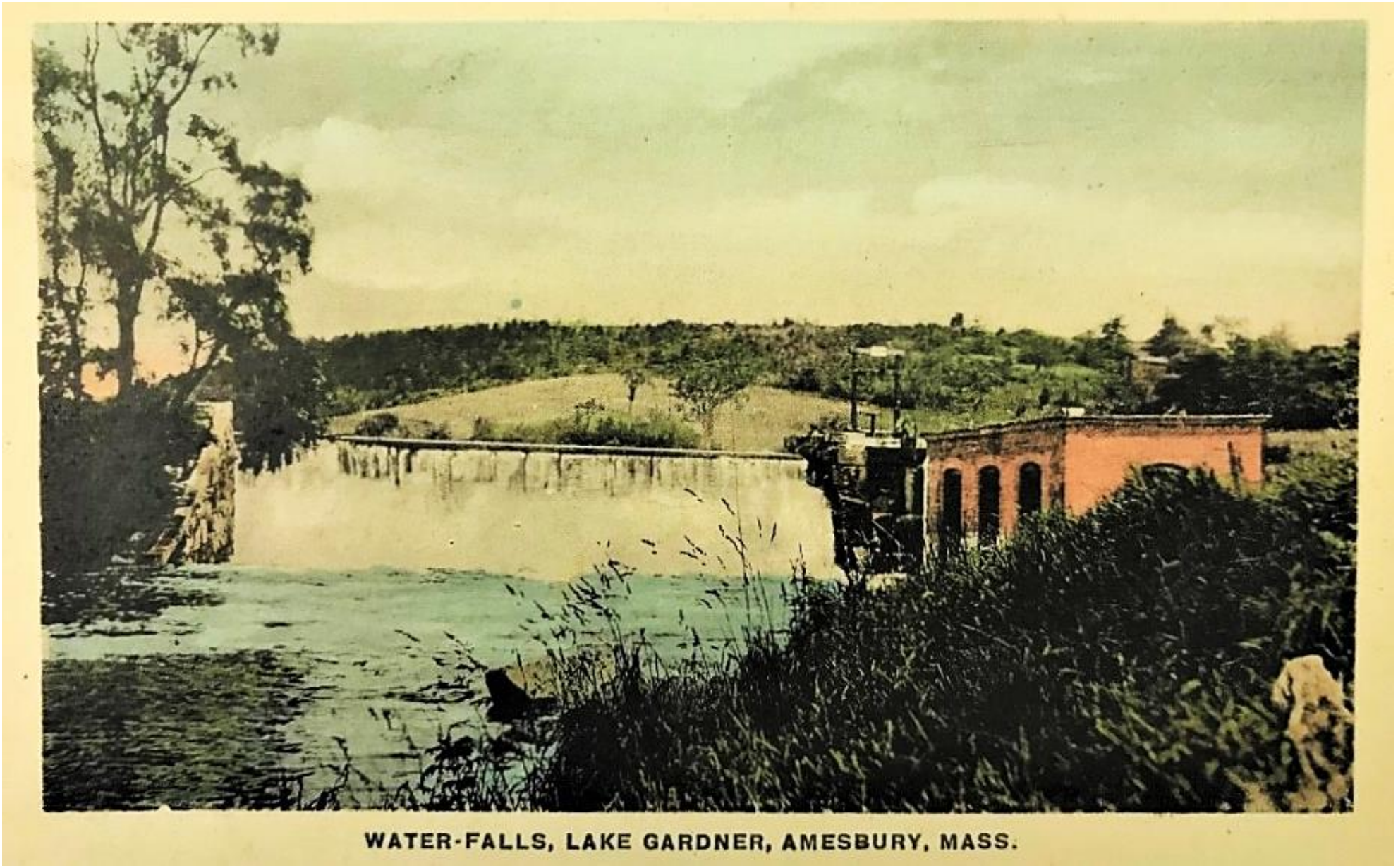
1916 penstocks in yellow, New England Power Ass'n. map of 12/29/1936

The original penstock to Mill #8 is a brick arch of approx. 16 feet diameter that a group of people could walk through, and was briefly visible when foundations for a new bank there were recently excavated.

The Mill #2 penstock is also of generous proportions. Mill #8 was disconnected from its penstock in 1916, and a new 6-foot diameter brick penstock was extended across Friend and Main Streets to the new hydro-electric generating plant at the Mill #6 location.



1916 Lake Gardner Dam & Hydro-Electric Plant, c. 1920



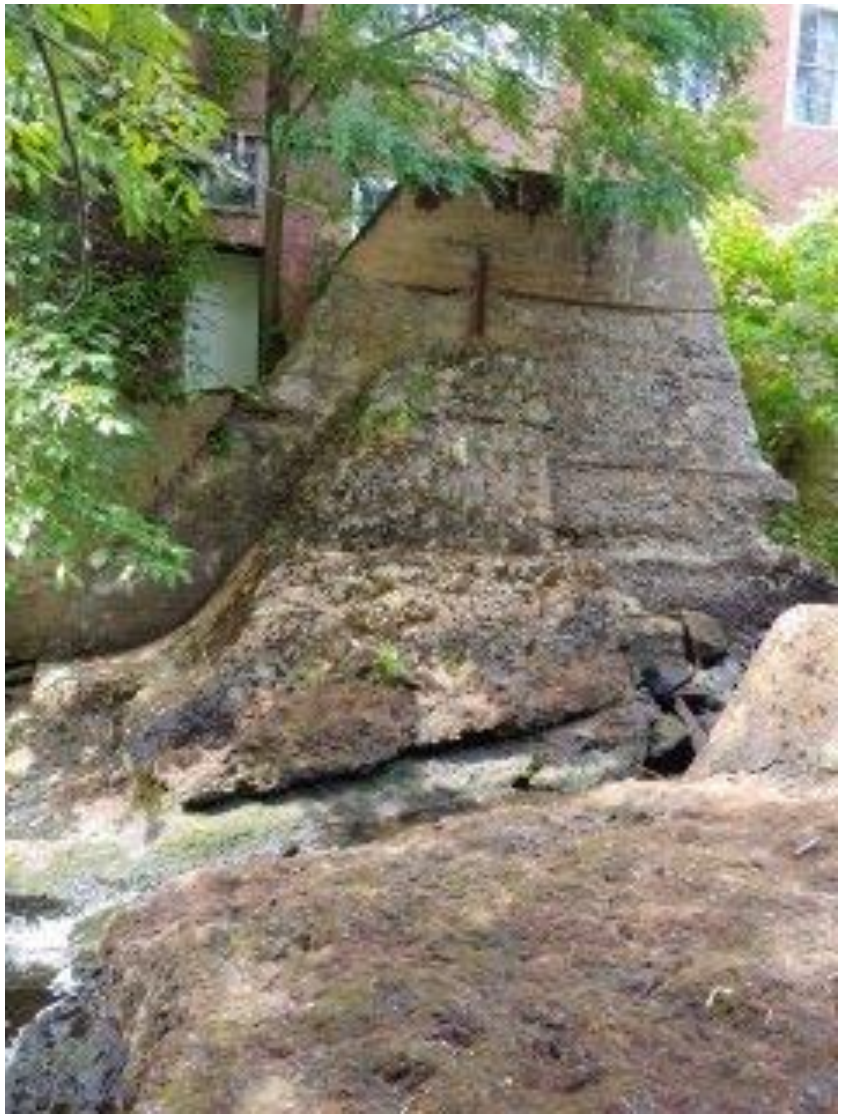
Post card courtesy of APL collection

Abandoned Lake Gardner Dam & Hydro-Electric Plant

B. Grodzicki photo, 1976. Building demolished ca. 1984

Remnants of the 1916 Concrete Version of Dam 3

Looking toward the side of Mill #7 at the end support of concrete Dam 3. The lower dam outline matches the opposite section at Mill #3, while the taller outline appears to be a larger support structure for that end of the dam.



Looking at the side of Mill #3 at the end of concrete Dam 3, supported by the concrete applied to the wall of Mill #3. The (broken) steam pipe was installed in 1910 to provide steam heat to from the old Mill #4 boilers.

Looking Up Mill Street Today

Mill #5 and #6 are gone, along with the textile mill fence and other buildings that extended down the hill, and today National Grid has expanded its transformer farm further down. They created a road down the grassy field paved with heavy wood beams that spread the weight of their trucks over a wide area, so as to not risk collapse of underground water raceways from the previous mills' waterpower facilities.

Current Mill #6 Hydro-Electric Plant Discharge

Seen today from Silvaticus Brewery courtyard

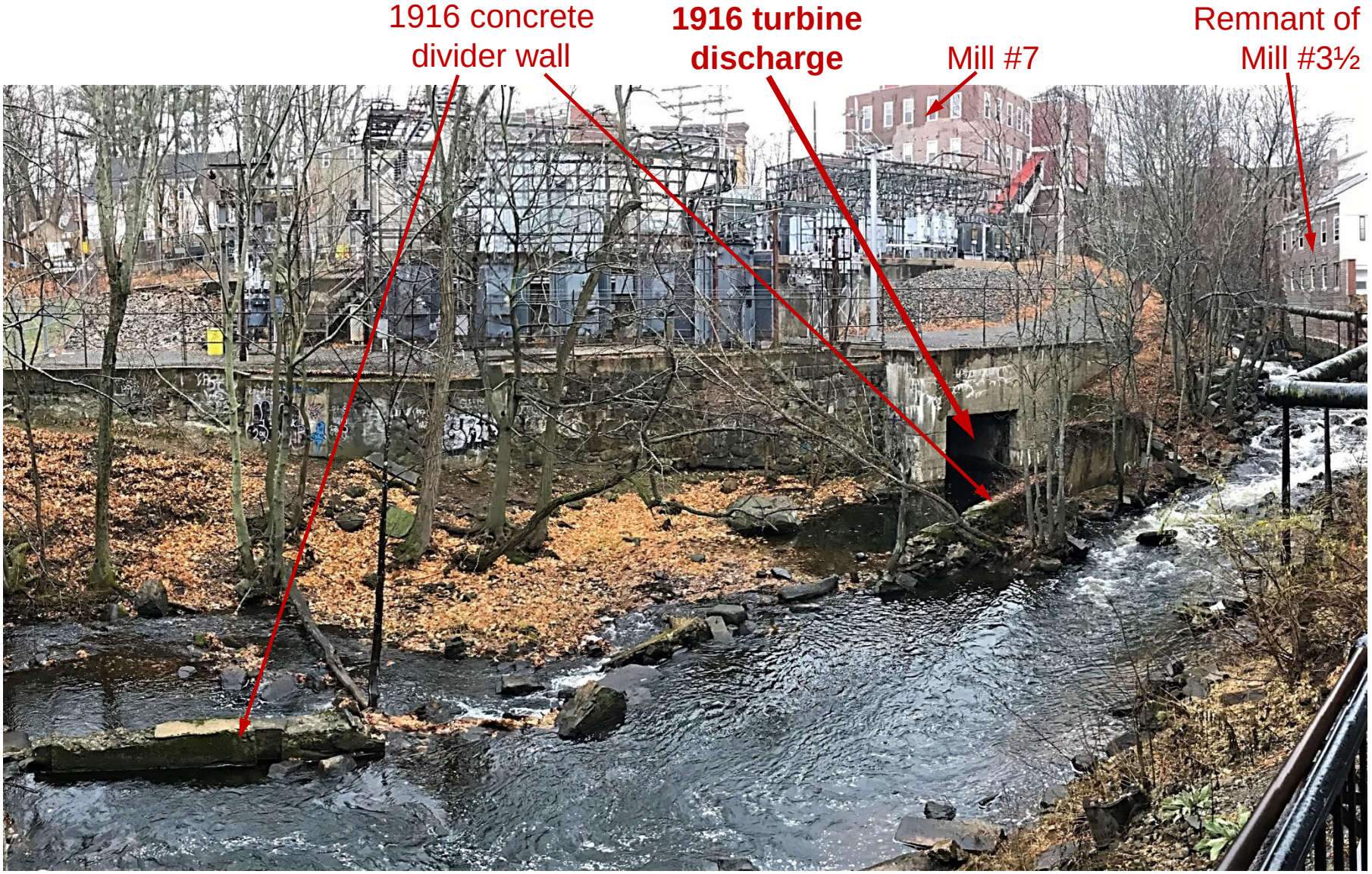


Photo courtesy of John Mayer

The low brick hydro-generating building over the discharge tunnel is now gone, replaced by a transformer farm, which extends on further to the left. Portions of the concrete divider wall remain in the river. Upper portions of Mill #3½ have been replaced by a wood structure.

Appendix I

Power Calculations

Horsepower from 1916 Data and 1878 Calculation

Where the 1878 published inventory represents the mills when they closed in 1876

Estimating mill complex power from water, steam, and electricity is approximate, but results seem reasonable to within perhaps 10%, anchored by several reality checks. Reaching the correct sum depends on finding all inputs and getting them correct. Large inputs got the most notice, while smaller changes may have been missed. Also, some inputs are a bit ambiguous or conflicting. Results have no more than two significant digits, for instance 170.81 cubic feet per second (below) really being no more reliable than the basic 170 number.

Water wheel and water turbine efficiencies (64% and 80% respectively) came from consultation with Patrick M. Malone, Professor Emeritus from Brown University in industrial archeology and history (correspondence of June 14, 2022).

The main uncertainty stems from many of the inputs being rated horsepower capabilities of water and steam power equipment, necessarily greater than power actually realized, even at high water flow. They must have excess capacity to handle all anticipated conditions. The 16 HP/ft is a normal maximum continuous level of operation, meaning for normal long term Powow River flow. It will be seen in several pages that the little available USGS Powow River flow data (from only about the last five years) in mostly below 170 cubic feet per second, but does encompass that level. A 1909 account mentions 233 cubic feet per second of capacity. Conditions for calculating 1878 normal continuous hydraulic horsepower yield are as follows:

16	Entitlement yield HP/Ft of drop (1918 Mass. Rivers report) assumes 80% efficiency							
170.8	Entitlement actual cubic feet per second of full water flow, 100% efficiency, from above HP yield							
11000	Entitlement actual pounds per second of full water flow, from above actual cubic feet per second							
0.64	1878 wheel efficiency (Patrick Malone)							
0.80	1878 turbine efficiency (Patrick Malone)							
0.90	1878 wheel drop factor, % of wheel diameter actually realized							
Potential hydropower =	1325	HP, actual entitlement water flow X full 66.25 feet of drop thru mill district						

Horsepower Production Capability at Each Mill, by Year

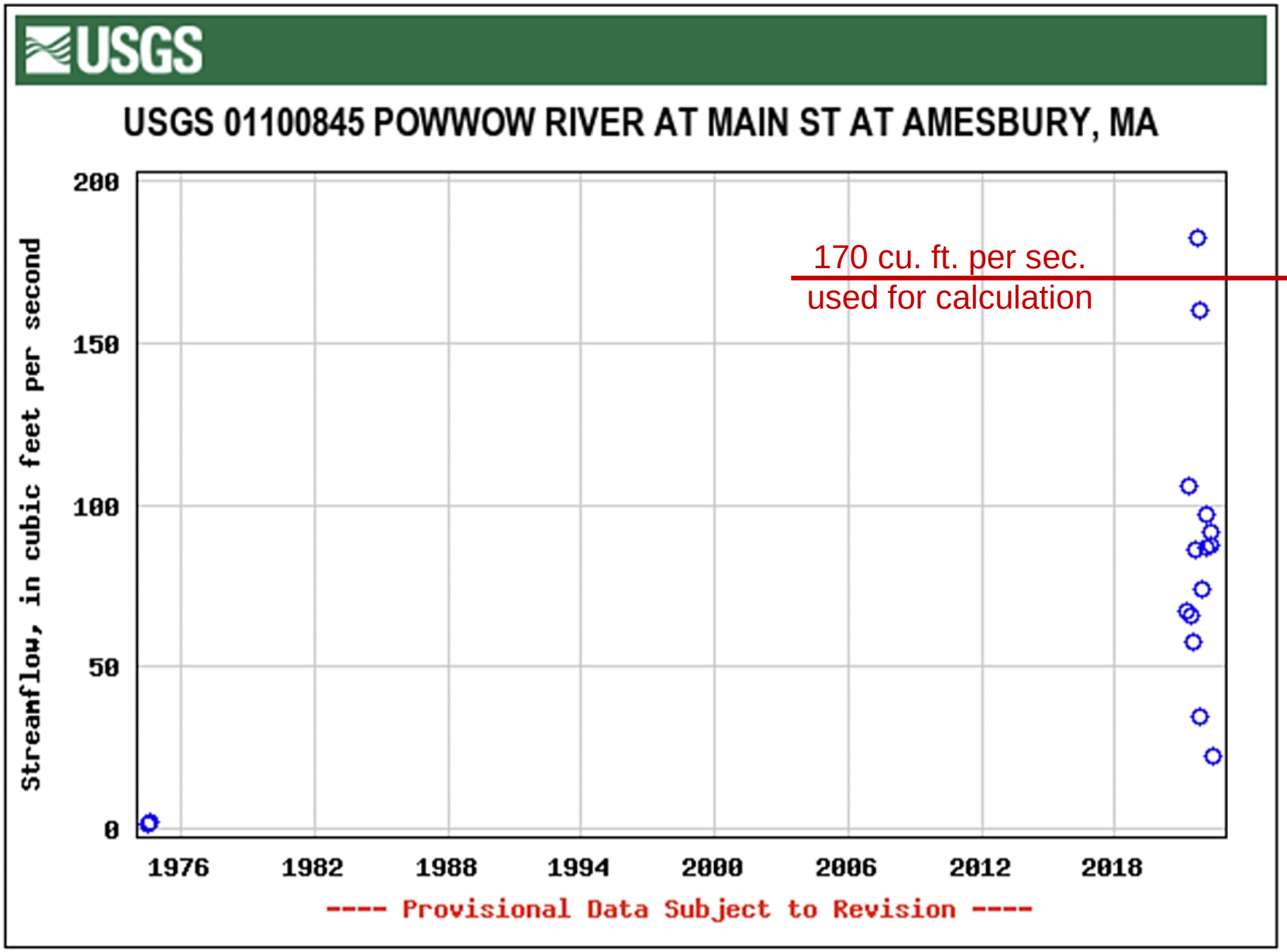
waterpower, steam power, electric power

			1862	1878	1882	1885	1889	1894	1904	1908	1909	1916	1918
Dam 1-2	Mill 2	Water	71	71	250	250	250	250	250	250	350	350	350
		Steam 1	60	60	60	60	60	60	60	60			
		Steam 2			125	125	125	125	125	125	700	800	800
		Electric									300	300	300
	Mill 8	Water	217	217	250	250	250	250	250	250	250		
		Steam 1		100	100	100	100	100	100	100	300	300	300
		Steam 2			500	500	500	500	500	500	500	500	500
		Electric											
Dam 3	Mill 3	Water	65	65									
		Steam											
		Electric											
	Mill 7	Water	97	97	97	97	97	97	97	97			
		Steam		80	80								
		Electric											
Dam 4	Mill 3½	Water	82	82									
		Steam		60	60								
		Electric											
	Mill 6	Water 1	137	137	137						500	500	500
		Water 2										1000	1000
		Steam											
		Electric									500	1500	1500
Dam 5	Mill 4	Water	142	142	150	150	150	150	150	150			
		Steam 1		80	200	200	200	200	200	200			
		Steam 2			250	250	250	250	250	250	250	250	250
		Electric											
	Mill 5	Water	47	47	47	47	47	47	47	47	47		
		Steam											
		Electric											

Calculation for last year of Salisbury Mills Co., based on 1878 published data

Waterflow of the Powow River

Cubic feet per second, based on measurements



Appendix II

Documents & Articles

1850s Steam Engines at the Textile Mills

Salisbury Mfg. Co. 1820-1857, Salisbury Mills co. 1857-1878

STEAM ENGINE For Sale.

ONE Steam Engine and Boiler for sale, 35 horse power—about as good as new, having been used about two years. Apply to

J. P. DERBY, Agent
Salisbury Manufacturing Co.

Amesbury, Aug 17th, 1852.

Newburyport Herald, September 7, 1852, pg. 3

REMARKABLE HONOR TO VETERAN ENGINEER

James Blanchard Started Engine in 1854 Stopped it For Last Time Wed.

James Blanchard, the veteran engineer, enjoyed a remarkable honor yesterday in an experience which will linger in his memory for life.

In the fall of 1854, Mr. Blanchard started the new engine in No. 2 mill. The engine has been employed ever since up to last evening when its career in furnishing the regular motive power for the mill ended and the act of bringing the engine to a stop after its half century of usefulness came to Mr Blanchard. It was indeed an event of interest, not alone to Mr. Blanchard but to the many other employees of the corporation who were aware of the fact that Mr. Blanchard had the distinction of first starting the engine. To the engineer himself it was a happy occasion and he was justifiably proud in halting the old engine after its long term of service.

The new engine will begin to furnish the power for the mill tomorrow morning. Tests have been made the last day or two and everything works perfectly. The new arrangement is greatly improved over the old and master mechanic J. C. Haile feels well pleased at the installation of the new mammoth engine, which is in line with several other improvements which have come about during his incumbency.

Amesbury Daily News, June 10, 1909, pg. 2

THE SALISBURY MILLS. If we should judge of the business operations of the Salisbury Mills by the extensive improvements made by the Company, we should say they were doing a successful and profitable business. Within the last six months three steam engines have been placed on the corporation to carry the works in case of a short supply of water, while in the No. 2 mill a new and improved water wheel of great power has taken the place of two old fashioned ones. In addition to this, new shafting has taken the place of the old, thereby materially lessening the friction and power necessary to be used in running the mill. A new flume has also been built, and with other improvements made and contemplated, continued prosperity must be anticipated by the company.

The cloths manufactured are of excellent texture and finish, and find a ready and rapid sale, while the stockholders have the satisfaction of realizing good dividends and of seeing their stock $30 above par in the market.

Such is the motive power of the company, that in case of a scarcity of water, nearly all the works can be run by steam.

The Villager, May 5, 1859, pg. 2

1882 Steam Engine Power for Mills #2, #4, & #8

OUR BUSINESS INTERESTS.

The change that has taken place in the business interests of this village within the last twelve months is most encouraging. A year ago and but a small portion of the Hamilton Woolen Mills was in operation while the preparation for the manufacture of cotton had not commenced. To-day every machine in the woolen department is in full operation, which comprises No. 1 and No. 7 mills. In addition to this nearly all the cotton machinery is in operation and the whole will be in the course of two weeks. The mills devoted to the manufacture of cotton, is No. 2 cotton cards, No. 8 spinning and No. 4 and 5 weaving—No. 4 weaving print cloth and 5 sheeting. The putting into operation of this large amount of machinery also requires the starting up of the 500 horse power engine in No. 8 mill, in addition to the new turbine wheels and the 200 horse power engine to operate No. 2. The working force of the mills is now about 1200. The monthly pay roll is $28,000.

THE VILLAGER

THURSDAY, MAR. 30, 1882

OUR BUSINESS INTERESTS.

THE VILLAGER.

THURSDAY, JULY 6, 1882

THE CELEBRATION OF INDEPENDENCE

The Hamilton Co., has nearly completed the foundation for its new engine in Mill No. 4, which necessitated the taking down of twenty square feet of the face granite wall of the factory.

New Engines, Generators, & Motors 1909

Electrification of the mills

Cashman Brothers are mak ing good progress in excavating for the founda tion of the new 800 horse power engine which will soon be installed in place of the one now in use at No. 2 mill.

Amesbury Daily News, March 11, 1909, pg. 3

A 250 K. W generator, equivalent to about 300 horsepower will be erected at No. 2 Mill on High street to be driven by engines furnishing power to mill recently installed.

Amesbury Daily News, August 16, 1909, pg. 3

The method of furnishing power electrically is a new adventure with the local company and two generators will be installed, one a 360 K. W. to be connected directly to the water wheel shaft at the No 7 Mill and another 250K.W. at No. 2 Mill on High street. The generator at the No. 7 Mill will furnish the horsepower necessary to run No. 7 mill besides transmitting four hundred horsepower to No. 4 Mill below. At such times during the year when there is a scarcity of water the generator at No. 2 Mill will transmit power to the motors of No. 7 Mill.

Amesbury Daily News, August 17, 1909, pg. 3

News report of 1909 new Dam 3, next page

Descriptions of 1916 modifications and construction can be found in the Amesbury Public Library digital online archive for:
Amesbury Daily News, August 29, 1916, pg. 2, and
December 4, 1916, pg. 2
Archive website:
http://amesbury.advantage-preservation.com/

AMESBURY DAILY NEWS, MONDAY EVENING AUGUST 16, 1909

EXTENSIVE CHANGES

Hamilton Woolen Co. to Put in New Concrete Dam

Will Use Its Water Power To Develop Electricity For Power and Light

In response to the many inquiries as to the nature and extent of the work now in progress on the premises of the Hamilton Woolen Company on Mill street Agent F. J. Quinn this morning authorized the following statement:

"Located at the rear of Porter's Car Station a wooden dam supplies water power on 10 foot head to two old vertical water wheels located in No. 7 Mill, the weaving mill at the corner of Main and Mill streets, the wooden flume for these wheels taking up about 50 per cent of basement floor space. This drive will be abandoned, a new concrete dam will be built about 15 feet below present dam which will be used as a coffer dam during erection of new one. A steel tube 8 1-2 feet in diameter, 3-8 in. thick running parallel with stream for about 125 feet will convey water to an additional fall of 17 feet, making 27 feet total fall, at this latter point two horizontal water wheels will be erected in a 10 foot iron flume using about 14,000 cubic feet of water per mimute, developing 500 horsepower.

A 360 K. W. generator will be directly connected to the water wheel shaft which will be capable of transmitting this power electrically to motors at desired points.

For such part of the year as there is water available for full capacity the 100 horsepower required for No. 7 Mill will be generated at the new station and transmitted to motors located on several floors of this building.

The additional 400 horsepower developed will be transmitted to motors in No. 4 Mill located on Water street

A 250 K. W generator, equivalent to about 300 horsepower will be erected at No. 2 Mill on High street to be driven by engines furnishing power to mill recently installed. During the dry season when there is not sufficient water available to run a part wheel in new water power station, the generator at No. 2 Mill will furnish power to motors in No. 7 Mill and for part of year will supply power for motors in Mill No. 4. Under present conditions engine are maintained at each of these mills to furnish power, running the entire year at No. 4 Mill.

The engine in basement of Mill No. 7 will be dismantled, the old flume torn down and the entire floor filled with additional weaving machinery after completion new water power station. For a considreable portion of the year, probably eight months, the engines and boilers on Water street at present is supplying power to mills on Water street and foot of Mill street will be shut down.

The cost of this equipment is estimated at $25,000.00 to $30,000.00 resulting in a development of the present water power and concentration of steam plant, effecting a considerable saving in fuel and operating expense.

A further additional development of water power is contemplated at Lake Gardner, installing water wheels transmitting power electrically to mills, the probabilities are that the latter developmenat will not take place for a year or two but is being worked out in connection with present installation which will require three months for completion."

AMESBURY DAILY NEWS, TUESDAY EVENING AUGUST 17, 1909

THINGS OF INTEREST

Concerning Changes By the Corporation

Electricity to Play Important Part in Future Running of the Mills

The extensive changes to be made by the Hamilton Woolen Company naturally bring to light much information regarding the plant in general.

The total power consumed in the operation of the plant amounts to the aggregate of 2000 horse power. The power obtainable from the water is now a thousand horse power, but with the completion of the present work near No. 6 Mill and that anticipated at Lake Gardner, the horse power will be increased to approximately 1900 from the fact it will be seen that the plant cannot be run entirely on water power, although the figures show that such a thing will come close to being done under the arrangement now planned. With a large outlay of money, it might be possible to run the entire plant on the water power, although this could be done only for a few weeks of the year when there was ample water in the stream. Because of the fact that these conditions would exist for only a short period of the year, it would not be profitable investment to go to the great expense of installing the equipment necessary to carry through such a project.

At the present time the mills use steam power solely, there being no water power, but under the new regime which is planned, the steam power will be reduced, the engines and boilers at the No. 4 Mill being out of commission for about two-thirds of the year.

The method of furnishing power electrically is a new adventure with the local company and two generators will be installed, one a 360 K. W. to be connected directly to the water wheel shaft at the No 7 Mill and another 250K.W. at No. 2 Mill on High street. The generator at the No. 7 Mill will furnish the horsepower necessary to run No. 7 mill besides transmitting four hundred horsepower to No. 4 Mill below. At such times during the year when there is a searcity of water the generator at No. 2 Mill will transmit power to the motors of No. 7 Mill.

By the tearing away of the machinery in the basement of No. 7 Mill an additional floor space can be utilized. Weaving machinery will be installed and when the new power station is completed this floor will be put in use.

The tearing away of the dam drive at No 7. Mill naturally creates an interest in the time of their constrution. The No. 7 Mill was built in 1848 but the company has no record of the building of the dam and hence nothing accurate can be stated, but it is probable that the dam may have been built even before the mill. One of the oldest of the employees of the company in length of service, John Armitage, foreman of the carpenter work, who rounds out a service of forty years in 1910, says that when he entered the employ of the company two score years ago the dam then looked as new as it does today. So that from these statements the dam is quite an old affair and the company has decreed that it has seen its period of usefulness and must come down.

One of the water wheels of No. 7 Mill was placed in position in 1873 and a peculiar coincidence is the fact that the same firm that installed the wheel at that time will probably have the contract for the new one.

Rumors of all kinds are floating about regarding the intention of the company, among them being one that the old No. 6 Mill will be put in use again, but this is ungrounded, for the structure which was built in 1812 would at this day probably not stand the wear of heavy machinery. The changes evoke much interest from a historical stand point.

The American Wool & Cotton Reporter

Compilation volume for the second half of 1910, edition of September 8, 1910, page 1340.


American Wool and Cotton Reporter

MID-MONTHLY CONSTRUCTION NUMBER

XXIV. No. 36 BOSTON, NEW YORK AND PHILADELPHIA, SEPT. 8, 1910 $3.00 Per A

three-quarters of a mile above the one shown, but the power is all rented to the Lewiston and Auburn Electric Light Company, and will be considered later.

Amesbury, Mass.

The methods used for furnishing and distributing power to the mills of the Hamilton Woolen Company, at Amesbury, Mass., have been greatly changed and improved during the last few years. The mills are located upon the banks of the Powow River and although this is a small stream, careful attention has been given to its storage lakes and considerable water power is available throughout the entire year.

Water Storage

The Powow River has its source in New Hamshire, and all its water privileges are controlled by the Hamilton Company. There are five reservoirs or storage lakes before the river reaches Amesbury, and these are of great value during dry seasons. Lake Gardner is the lake nearest the mill and then in order come Lake Attitash, Tewksbury's Pond, Country Pond, and a small storage basin just above some falls known as Trickling Falls.

The river has a fall of about 60 feet inside the mill yard and this is utilized in three stages. In other words the same water is used three times before leaving the mill.

The water wheels are all modern and have been installed during the last 6 or 7 years. There are four wheels each rated at 175-horse power, one of 140-horse power, one of 85-horse power and one pair which can furnish about 600-horse power.

There are three separate engine rooms, but one of them is not used, as its former load is now driven electrically. Three or four years ago there was no electricity whatever used by the mill either for light or power, while to-day about 900-horse power may be taken from the electric generators. New engines and water turbines have been installed and the economy of the power plant is still increasing.

Machinery Driven

Nearly 2,000 cotton looms and something like 62,000 ring spindles with the necessary preparatory machinery are operated at these mills and for convenience we will divide the plant as follows: picker department, mill No. 2, mill No. 4, mill No. 5, mill No. 7 and mill No. 8. Mill No. 2 contains cards, drawing frames, slubbers and speeders; No. 4, No. 5 and No. 7 are used for weaving machinery and No. 8 has four floors of spinning frames with spoolers and slasbers on the other.

There are two engine rooms now in use, both of which receive steam from the same boiler house. A 300-horse power electric generator is driven by a steam engine which also transmits mechanically approximately 200-horse power, and another steam engine is used entirely for mechanical transmission. The pair of water wheels rated at 600-horse power are directly connected to an electric generator, but all of the other water wheels are arranged to help the engines in handling the mechanical load.

The Engines

Engine room No. 2 contains a Rice & Sargent cross-compound engine doing from 600 to 800 horse power. It runs condensing with a barometric condenser and transmits its power to the main shaft by a large leather belt. From this shaft enough power is taken to drive the 300-horse power generator which has already been mentioned, and the remaining power is distributed by shafts and belting.

Engine room No. 3 formerly contained a pair of Greene twin engines, but these have been changed by the installation of a new Hewes & Phillips low pressure cylinder into a cross compound unit. The high pressure cylinder is 24 and the low pressure cylinder 44 inches in diameter and the engine makes 115 revolutions per minute. A jet condenser is connected to this engine and furnishes a vacuum of about 26 inches. Water for all condensing purposes is taken directly from the river.

At the No. 4 engine room there is a simple Greene engine which, as stated, is not being used now that the new 600-horse power generator is in operation.

The Boilers

Steam used to be furnished by two separate boiler plants. One of these is near the No. 2 engine room and the other across the street in No. 4 mill. The installation of the new water wheels and direct connected generator has considerably reduced the coal consumption, for the battery of 4 boilers in the No. 4 mill are never used except for heating that part of the mill in winter. Three and often all four of these boilers were required formerly in addition to seven used in the No. 2 power house, while to-day six boilers in room No. 2 furnish all steam re-

1912 Demolition of Mill #6 and Closure of Hamilton Mills

MILL WAS BUILT ONE HUNDRED YEARS AGO

The large brick mill known for many years as Number Six, on Mill street, to be torn down by Cashman Brothers Company of Newburyport, by whom it has been purchased from the Hamilton Woolen Corporation, is one of the historic landmarks of Amesbury.

It is one hundred years old built in 1812 being the first place where the cotton and woolen manufacture started, that finally received into the present business of the Hamilton Woolen Company now employing about 800 persons.

In an interview with Agent F. J. Quinn, of the Corporation, as to the purpose of the sale of the No. 6 Mill he said that it is of no value from a manufacturing standpoint, returning no revenue for a great many years, and has been only a source of expense. For this reason, he said that it had been decided to dismantle the mill, and it is understood that there are several other buildings, it is contemplated to tear down.

For a great many years Number Six Mill has been occupied for only short periods.

The first owners of the building were the Amesbury Wool and Cotton Company. They sold the brick mill to the Salisbury Manufacturing Co. who in turn sold out to the Salisbury Mills Company. The Essex Manufacturing Company then purchased the mill although not a wheel turned in the three years they were the owners. The brick mill was then bought from them about thirty years ago by the Hamilton Woolen Company.

Among the firms which have done business in this structure in recent years were Kendall, Lant & Company, manufacturers of gears, wheels and bodies, Carr & Prescott, wheels; and Gray & Davis, automobile lamps who started their present large business here. These concerns, however, occupied No. Six Mill for only short terms.

It may be of interest to many citizens to know what is said of the Number Six Mill in Merrill's History of Amesbury, appearing under the year of 1812, which reads as follows:

"A new branch of business was this year introduced at the Mills, which has since become the principal business of the village. The company was organized for the manufacture of Satinet, and a brick mill built on Mill street. The company consisting in part of the following persons: Ezra Worthen, Paul Moody, Thomas Boardman, Jacob Kent, Mr. Rundlett and Mr. Wigglesworth, Ezra Worthen was the agent. The mill was two stories high at first but raised to three, and afterward greatly enlarged. During the war times a good business was done here, and it was a valuable acquisition to the place. It is now known as No. 6. According to tradition, when the bricks were being made a young lady and her beau had the curiosity to visit the yard, and the former taking a little stick wrote her name and the year on several bricks which were spread out to dry. The bricks were laid in the wall of this mill, and the year may yet be seen."

Amesbury Daily News, April 16, 1912, pg. 2

100-YEAR-OLD MILL TO STOP

Amesbury Concern Will Go Out of Business

AMESBURY, Aug. 10.—The Amesbury cotton mills, which have been in operation here for 100 years, will be closed permanently within a few weeks.

The heavy expense of replacing old fashioned machinery with the modern sort is given as the reason for the shutdown by the Hamilton Woolen Company, which owns the plant.

By the closing of the mills nearly 1000 people will be thrown out of work. There was a weekly expense bill of $5000. The shut down also will mean a loss of $12,000 in taxes to the town.

Much historical interest is attached to the Amesbury mills. It was in these mills that the blankets used by the American soldiers in the war of 1812 were woven. In 1817 President Madison inspected the plant.

The original mill was torn down early in the spring of this year. The last building of the mill group to be erected was constructed in 1852.

The Boston Sunday Post, 8/11/1912, pg. 20

1918 Massachusetts Waterways Report on Powow River

SENATE No. 289

REPORT

OF THE

COMMISSION ON WATERWAYS AND PUBLIC LANDS

ON THE

WATER RESOURCES

OF

THE COMMONWEALTH OF MASSACHUSETTS

THEIR CONSERVATION AND UTILIZATION

TOGETHER WITH THE

REPORT OF THE ENGINEER OF THE COMMISSION

1918.

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET
1918

Powow River.

This stream rises in the town of Kingston, N. H., and flows by a very crooked course in a southeasterly and southerly direction until it finally joins the Merrimack River by a rather long tidal estuary, at a sharp bend opposite the northerly point of Newburyport. The basin is about 10 miles northwest and southeast, and about 4 to 6 miles wide, and has a drainage area above Gardner Lake of about 51 square miles. The average rainfall from 1893 to 1913 was 39.8 inches.

The basin is thinly settled, except for the village of Amesbury, near the mouth, which has about 8,500 inhabitants and a number of mills and factories. The general slope of the basin is rather flat, although dotted here and there with hills about 300 feet high, and the soil is sandy. It contains eleven ponds and reservoirs of sufficient storage capacity to produce a very even and serviceable flow, which develops considerable water power due to the fact that the fall or head is concentrated within a half mile of the outlet of Gardner Lake, the lowest pond in the system.

The total fall between East Kingston and the mouth, a distance of 9½ miles, has been computed by Professor Porter to be about 122 feet, of which about 85 feet occur within a half mile of Gardner Lake as above mentioned, where the actual developed head is 81 feet. The total area of all the ponds is over 2,200 acres, and the total storage, not including Gardner Lake is estimated at over 437,900,000 cubic feet, which is all under the control of one company.

There are only two towns in Massachusetts within the basin, namely, Amesbury and Merrimack, the former with a population in 1915 of 8,543, and the latter, 2,101. The rest of the basin is within the State of New Hampshire in Rockingham County, and includes parts of Danville, Sandown, Hampsted, Kingston, East Kingston, Newton and South Hampton.

Water Power.

The Merrimac Valley Power and Buildings Company is the sole owner of the water privilege, having bought the same from the Hamilton Woolen Company in 1916. The entire system of

1918 Massachusetts Waterways Report on Powow River

power has been remodeled within the past two years, so as to get the full benefit of all the yield of the basin by means of nearly complete regulation. The whole system is tied together electrically so that a single control is maintained at the new power station some distance below the lower dam, with no operators in attendance at Gardner Lake or other points.

Formerly the power was obtained from six dams built very near together, with Gardner Lake used for storage only, being drawn down by day and refilled or partly refilled at night, so that the total installed capacity of 1,000 horsepower was only available for about three months of the year. At present, as redeveloped, power is created by two dams below Gardner Lake, the nearer supplying a 1,000-horsepower turbine under 65 feet head, and a 350-horsepower turbine under 23 feet head. The former develops its high head at the power station by means of a penstock which by-passes the second dam below.

The second or lower dam supplies a 500-horsepower turbine under 29 feet head. Another turbine has been installed at Gardner Lake Dam, which develops 220 horsepower under 16 feet head, and is operated by an automatic electrical control at the power station, so that it acts as an outlet or control gate for the lake, in place of the old gate house which formerly required an attendant. Only the top foot of the lake is drawn from, so as to give continuous flow for twenty-four hours each day. The turbine at Gardner Lake and the 1,000-horsepower unit are ordinarily operated together, both using the same amount of water, and the 350-horsepower and 500-horsepower units are operated during periods of excess flow.

The company maintains a steam plant of 2,000 horsepower and is tied in electrically with the Newburyport Gas and Electric Light Company by means of a transmission line 5½ miles long and 2,000 K. W. capacity. The company supplies its tenants, about 12 in number, with light and power, and also supplies the current used by the Amesbury Electric Light Company.

Table No. XXXVIII., on page 222, shows the details of the water powers, and Table No. XXXIX., on page 223, the principal lakes and ponds, with various details.

TABLE XXXVIII. — *Water Power on the Powow River in Massachusetts.*

[S. indicates steam; E., electricity.]

No.	Name of Company.	Location.	Product.	Number of Working Hours.	Drainage Area (Square Miles).	Rated Horsepower of Water Wheels.	Average Head (Feet).	Discharge in Second-feet per Square Mile at 80 Per Cent. Efficiency.	Auxiliary Horsepower.
1	Merrimac Valley Power and Buildings Company,	Amesbury,	Light and power,	21	50.63	500	29	3.74	2,000 S.
2						1,000	65	3.35	2,000 K.W.E.
						350	23	3.31	-
3	Total,	-	-	-	-	220	16	2.99	-
						2,070	-	-	-

TABLE XXXIX. — *Principal Lakes and Ponds on the Powow River in Massachusetts and New Hampshire.*

[Except where otherwise noted, areas are obtained from original plane table sheets of State topographical map. Scale, 1:30,000.]

No.	Name of Pond.	Town.	Flow regulated by—	Drainage Area (Square Miles).	Area of Pond (Acres).	Draft (Feet).	Estimated Storage (Million Cubic Feet).	Remarks.
1	Angle Pond,	Hampstead-Sandown, N. H.,	-	2.02	81	-	-	-
2	Cub Pond,	Danville-Sandown, N. H.,	-	.84	45	-	-	-
3	Long Pond,	Danville-Kingston, N. H.,	Merrimac Valley Power and Buildings Company.	4.10	87[1]	5.5	20.80	Total storage, 437,900,000 cubic feet.
4	Little Kingston,	Kingston, N. H.,		1.35	81[1]	5.0	10.55	
5	Great Kingston,	Kingston, N. H.,		9.48	290[1]	5.0	62.00	
6	Country Pond,	Kingston-Newton, N. H.,		16.83	600[1]	4.5	115.00	
7	Trickling Falls Pond,	East Kingston, N. H.,		35.50	467[1]	7.5	90.00	
8	Tuxbury Pond,	South Hampton, N. H.,		-	150[1]	7.5	32.00	
9	Coombs Pond,	East Kingston, N. H.,		-	75[1]	3.0	9.50	
10	Lake Attitash,	Amesbury-Merrimac,		46.80	350[1]	8.0	97.00	Kimballs Pond, Includes Tuxbury and Coombs.
11	Gardner Lake,	Amesbury,		51.00	80[1]	8.0	20.00	-