



Lesson 11.1: Water Power



George Washington's Vest, circa 1780–1800
Source: New Hampshire Historical Society



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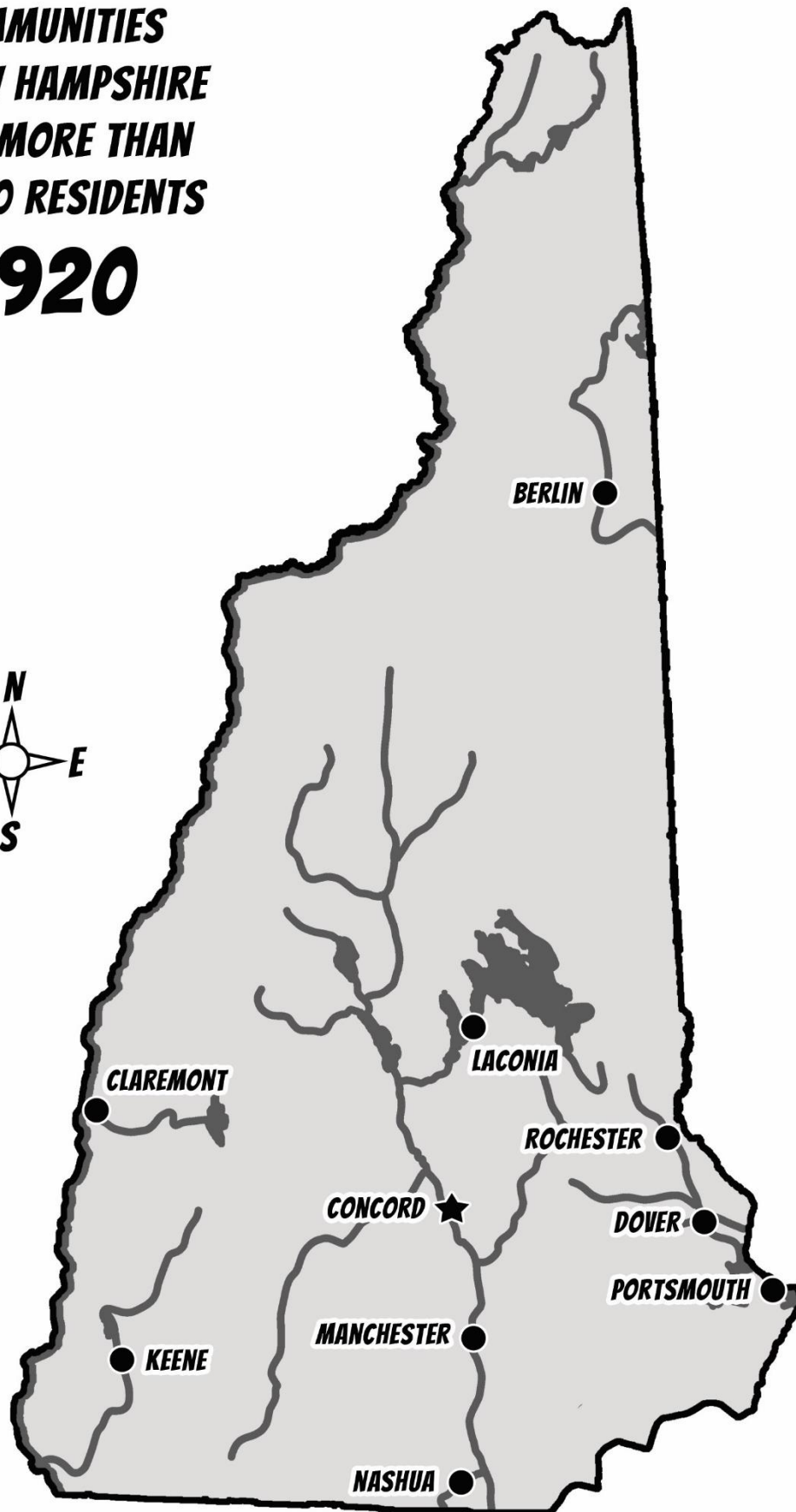


George Washington's Vest (inside), circa 1780–1800
Source: New Hampshire Historical Society



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**COMMUNITIES
IN NEW HAMPSHIRE
WITH MORE THAN
10,000 RESIDENTS
1920**





Lesson 11.1: Water Power

WATER POWER

The first textile mills in New Hampshire were powered by water. People built them next to rivers. But how did people use the power of the river to run the machines?

1 Find a powerful river and build a **dam**. The dam will slow the water down and turn that part of the river into a pond. This is called a **mill pond**.

MILL POND

DAM

2 Cut a **head race** to the mill. A head race is a narrow channel of water that flows quickly downhill to a mill. The water in the head race turns the **waterwheel** by pushing against big paddles.

HEAD RACE

4 Gears on each floor connect the main shaft to each floor's **power train**. The power train turns the **pulley**, which is made of a wheel and a leather belt.

MAIN SHAFT

GEARS

PULLEY

POWER TRAIN

5 Each pulley is attached to a machine. As the pulley turns, it moves the parts of the machine. The machine now has power to make it run!

3 When the waterwheel turns, it turns the **gears**. The turning of the gears spins a thick pole called the **main shaft**. The main shaft goes up through all the floors of the building.

WATERWHEEL

MAIN SHAFT

GEARS

Lesson 11.1: Water Power

Name _____

Water Power in Action

Complete the tasks below to build a waterwheel and test the power of water, also called **hydropower**. You need: an aluminum pie plate, a pair of scissors, a pencil, a piece of masking tape, a permanent marker, a basin, and a pitcher of water.

Build

1. Use the scissors to make eight (8) equally spaced cuts on the side of the pie plate. The cuts should go from the rim, down the side, to the base. Mark your planned cuts before you cut.



2. Fold each cut section backward so that it sticks out over the base of the pie plate. Be careful! The edges of the flaps may be sharp. You should have eight flaps that slightly overlap each other.



3. Use the point of the pencil to poke a small hole in the center of the pie plate's base. If the pencil doesn't work, ask an adult to use the point of the scissors to make the small hole.



4. Fold a piece of masking tape around the pencil near the eraser end to make a tab. Use the marker to draw an "X" on one side of the tab.



Observe

1. First, experiment with human power. Hold the pencil horizontally and use both hands to turn it in one direction continuously. Have a partner count the number of times you are able to turn it in one minute by counting each time the "X" returns to the top. Record that number here: _____
2. Now, experiment with hydropower. You have a model of a waterwheel with a main shaft. Hold your water wheel and shaft over the basin. Make sure you hold the shaft loosely so that it can rotate. One partner should pour the pitcher of water in a constant stream onto the water wheel so that it rotates in one direction and spins the shaft. The tape tab will rotate as the wheel rotates. This may take a few attempts to work.
3. When you are ready, have another partner count the number of times the "X" returns to the top during one minute of constantly pouring water onto the water wheel. Record that number here: _____



Lesson 11.1: Water Power

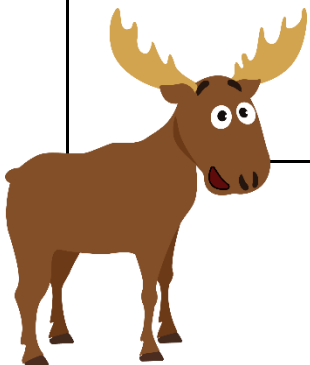
Adjust

1. Extra rainfall and melting snow make rivers move faster. What happens to the rotation if you pour the water out of the pitcher more quickly? Record the number of "X" rotations in one minute during a fast stream of water:_____
2. More mills on a river meant more dams, which slowed down the movement of the river. Try pouring the water slowly. Record the number of "X" rotations in one minute during a slow stream of water:_____

Reflect

Compare your experience using human power and hydropower to rotate the pencil, especially, which method resulted in more rotations per minute?

Why do you think mills decided to use hydropower instead of relying on human power to make machines move?





Lesson 11.1: Water Power

STEAM POWER

Steam power was one of the most important new technologies in the 1800s. It was much stronger than water power and made machines in factories move faster.

1 Find a powerful river and build a **dam**. The dam will slow the water down and turn that part of the river into a pond. This is called a **mill pond**.

MILL POND

2 Build an **intake pipe** to bring water from the pond to the factory. The water goes into the **boiler**. The fire in the boiler, powered by wood or coal, boils the water.

DAM

6 The gas from the engine cools down. It condenses back into water. A pipe takes the water back **out** into the mill pond.

OUT

4 Gears on each floor connect the main shaft to each floor's **power train**. The power train turns the **pulley**, which is made of a wheel and a leather belt.

MAIN SHAFT

3 When the water boils, it turns to gas. The gas is pushed into the **engine**. The gas pressure makes the engine move. A metal bar turns a wheel attached to some **gears**. Turning the gears spins a thick pole called the **main shaft**. The main shaft goes up through all the floors of the building.

INTAKE PIPE

GEARS

PULLEY

POWER TRAIN

5 Each pulley is attached to a machine. As the pulley turns, it moves the parts of the machine. The machine now has power to make it run!

BOILER

ENGINE



Lesson 11.1: Water Power

Steam Power Steps

Cut along the dotted lines and shuffle the cards before giving a set to students.

A pump brings water from a mill pond through a pipe and into a holding tank.

A coal-burning fire heats the water inside the holding tank.

The heated water transforms into a gas called steam.

The steam rises and moves through a system of pipes into an engine.



Lesson 11.1: Water Power

The pressure of the steam moves the engine's parts.

The movement of the engine makes the other machines in the mill work.

The steam cools back into a liquid.

This liquid water moves back through another system of pipes back out to the mill pond. The process begins again!



Lesson 11.1: Water Power

Steam Power Steps (in order)

1. A pump brings water from a mill pond through a pipe and into a holding tank.
2. A coal-burning fire heats the water inside the holding tank.
3. The heated water transforms into a gas called steam.
4. The steam rises and moves through a system of pipes into an engine.
5. The pressure of the steam moves the engine's parts.
6. The movement of the engine makes the other machines in the mill work.
7. The steam cools back into a liquid.
8. This liquid water moves back through another system of pipes back out to the mill pond. The process begins again!



Lesson 11.1: Water Power

Name _____

Venn Diagram: Hydropower vs. Steam Power

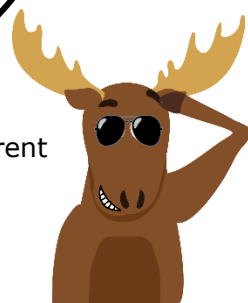
Hydropower

Steam Power

different

similar

different





Venn Diagram: Hydropower vs. Steam Power

Hydropower

Steam Power

- Requires a constantly flowing water source, like a river.
- Mill must be built near or on a river.
- Mill machine operation impacted by flooding or drought that changes water level.
- Multiple dams for multiple mills on one river slows the water flow.

- Transform water's energy to power machines.
- Require people to maintain machines.
- Increase the amount of work a machine can do.
- Increase the amount of product a mill can make.

- Requires a source of water, like a mill pond or water pumped from a river or lake.
- Mill can be built far away from water source.
- Uses heat to transform liquid water into gas.
- Pressure of gas makes machines in mill work.
- Gas cools back into liquid and returns to holding tank or pond; same water can be reused.
- Not dependent on weather or water flow.

different

similar

different



Lesson 11.1: Water Power

Name _____

Water Power Reflection

The tools we use to complete tasks (technology) are always changing. Think of an example of technology that your parents or grandparents used that was replaced by something you use today. Why do you think that change occurred?

Now think about the technology that changed the way people made products, like cloth. Why were the water wheel and hydropower an improvement over human power?

Why did mills change from simple hydropower to more complicated steam power? How did steam power affect industries in New Hampshire?

Why do you think technology is always changing? Why do we experiment with new ways of getting work done?



Lesson 11.1: Water Power

Next step: Use this space to organize your responses to the questions into an informational paragraph that explains how new technology changed industry in New Hampshire.





Water Power Reflection

The tools we use to complete tasks (technology) are always changing. Think of an example of technology that your parents or grandparents used that was replaced by something you use today. Why do you think that change occurred?

My mom used to have to wait to make a phone call until she was back at home because they only had land line telephones. Today, everyone has a mobile device that can make calls from anywhere. People travel more and want information faster, so they needed technology to communicate even if they weren't at home.

Now think about the technology that changed the way people made products, like cloth. Why were the waterwheel and hydropower an improvement over human power?

Before the waterwheel-powered mill, people had to power machines themselves to make the things they needed. Everything, from sawing lumber to grinding grain to weaving cloth took a long time. People realized they could make more of the products they needed in less time if they used power from another source to make their machines work.

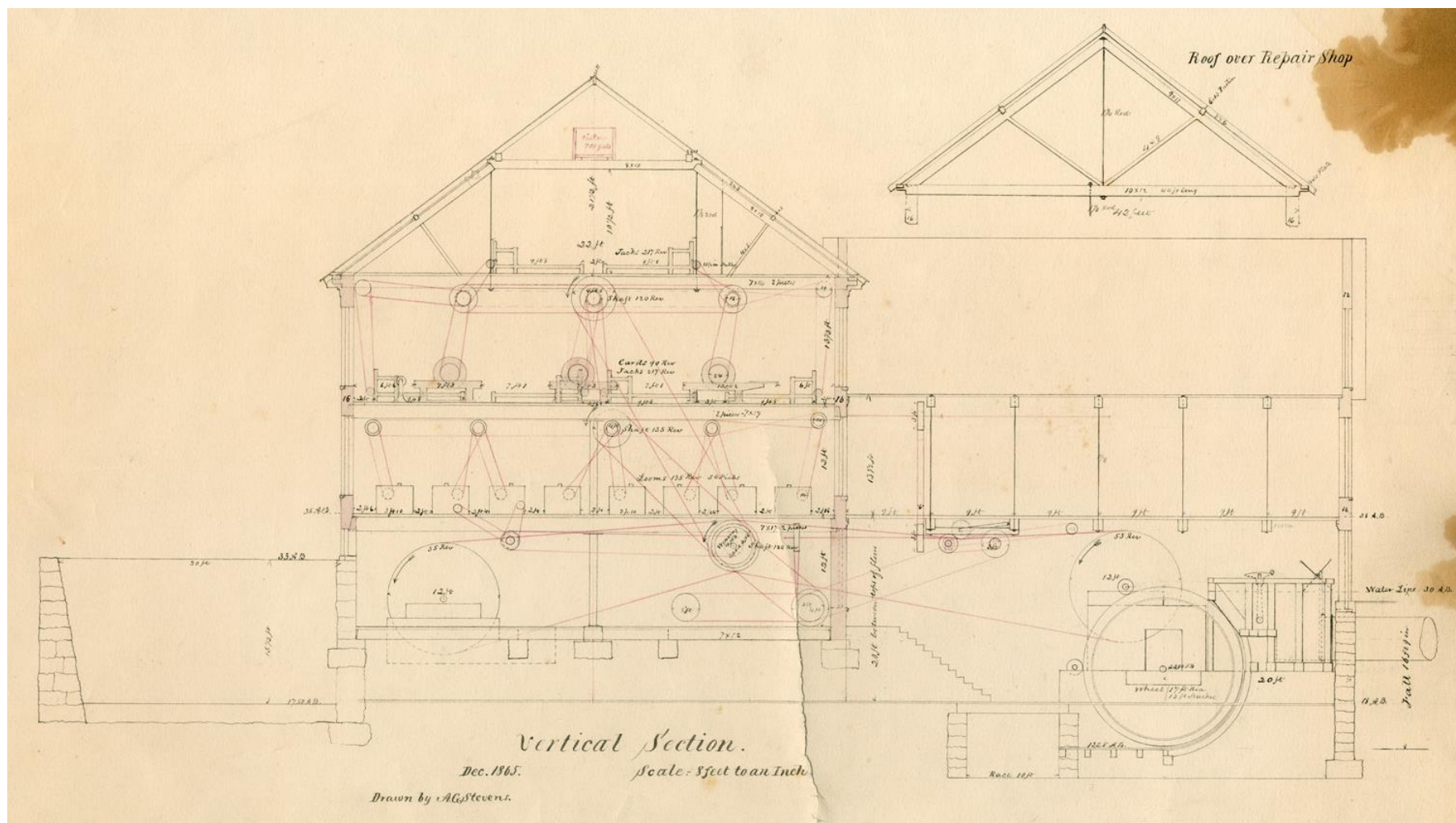
Why did mills change from simple hydropower to more complicated steam power? How did steam power affect industries in New Hampshire?

One of the biggest disadvantages of hydropower was that waterwheels were dependent on a steady flow of water. If the water level dropped because of drought or slowed because of other dams built by other mills, the wheel would not move as fast and the machines in the mill would not do as much work. Steam power eliminated that disadvantage. Steam power reuses the same source of water over and over, transforming it from a liquid to a gas in order to make an engine work. Mills could be built anywhere if they used steam power, not just along rivers. More mills meant more production. Industries in New Hampshire grew and more people worked in factories and bought more factory-made products.

Why do you think technology is always changing? Why do we experiment with new ways of getting work done?

People's needs and wants change over time. As people change from lives on farms, where they make and grow everything they need, to lives spread out across cities and suburbs, they depend on others to make and grow the things they need. As populations grow, more products are needed and new technology helps make work happen faster and increases the number of products for people to buy.

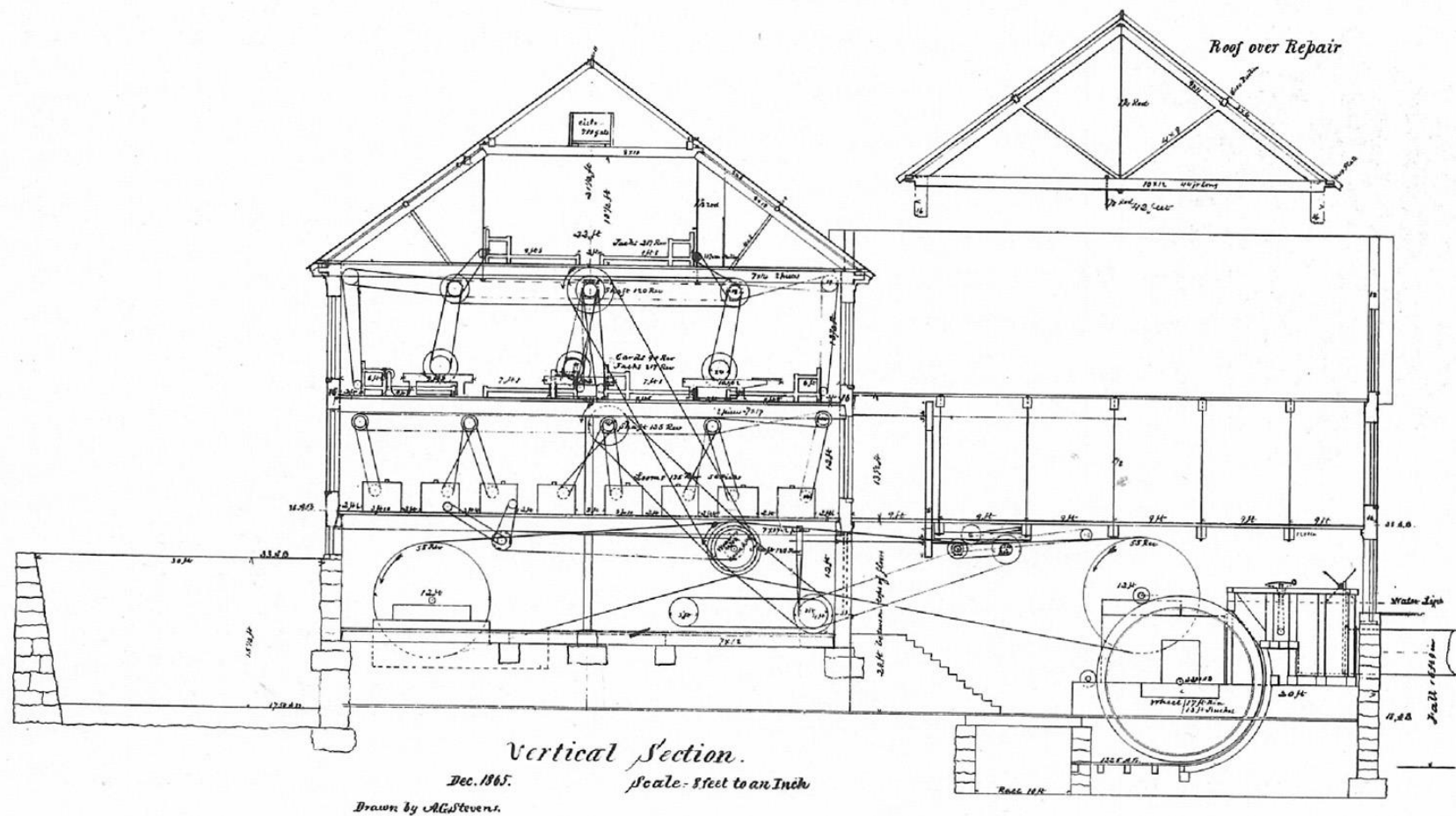
Lesson 11.1: Water Power



Stevens Mill, 1865
Courtesy of the Kheel Center, Cornell University



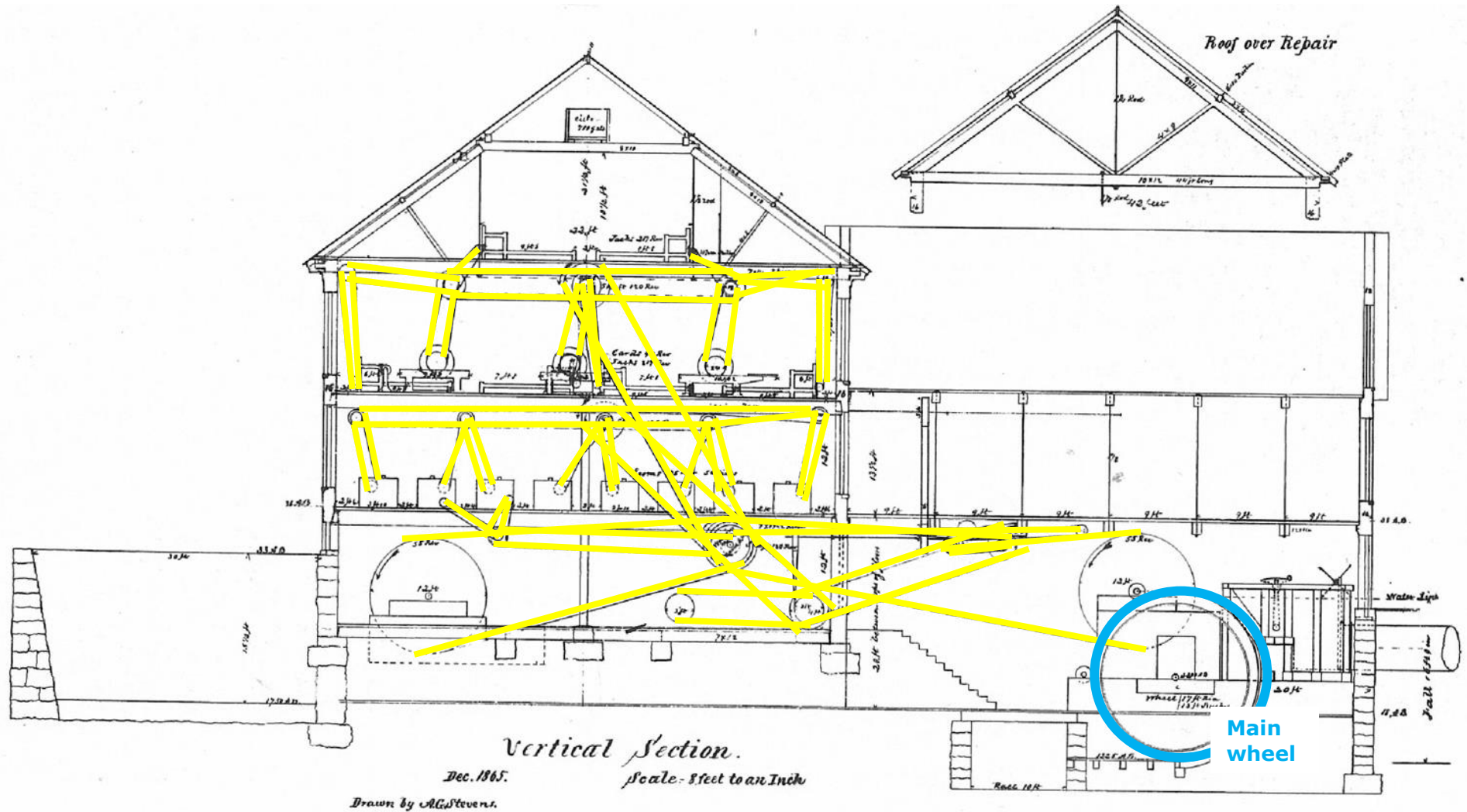
Lesson 11.1: Water Power



Stevens Mill, 1865
Courtesy of the Kheel Center, Cornell University



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