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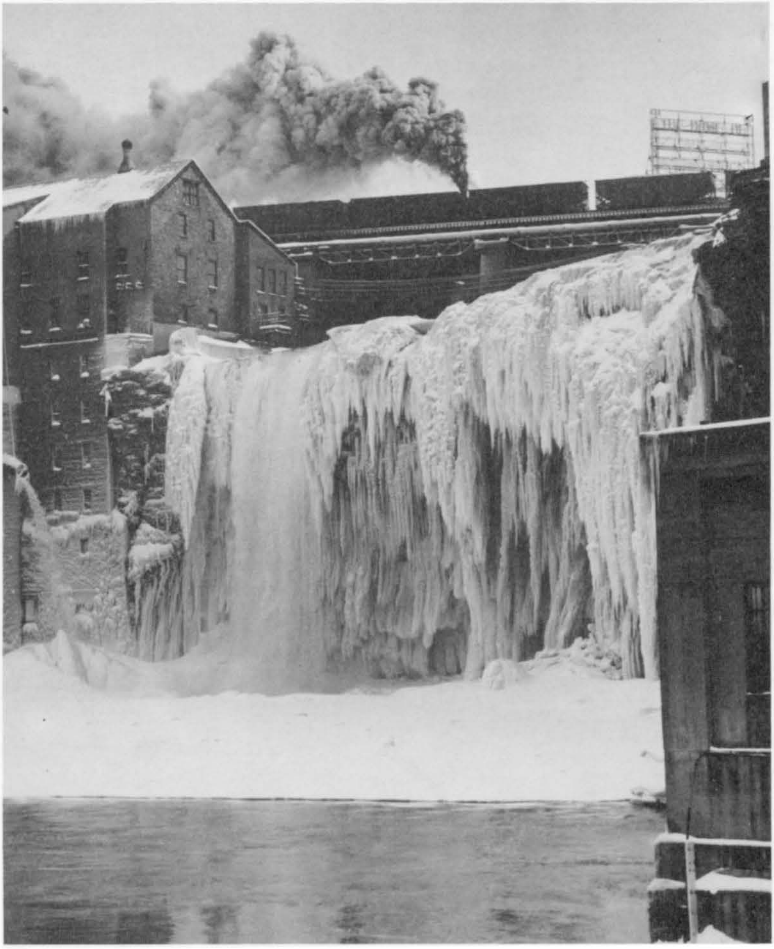
Geology and Industrial History of the Rochester Gorge Part One

by Thomas X. Grasso



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This issue is the first of a two-part study of the geology of the Genesee River Gorge.

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Front Cover: High Falls Winter circa 1940s.

GEOLOGY AND INDUSTRIAL HISTORY OF THE ROCHESTER GORGE

Part I

INTRODUCTION

The Erie Canal came to Rochester in 1822-1823, and the "Young Lion of the West" was born. The appellation was accurate enough as evidenced by the economic explosion and unparalleled physical growth, fostered by the canal, that was this city's hallmark in the first quarter of the 19th Century. The original Erie Canal was only 40 feet wide at water surface, 28 feet wide along the bottom and just 4 feet deep. Yet this narrow ribbon of water made New York the Empire State, and Rochester the first "boom town" in America. The canal lowered transportation costs by more than 90% and the rapid growth that resulted is clearly revealed by the fact that 3,130 souls resided in the Village of Rochesterville in 1822, more than double the population only two years before. Further affirmation is found in the 1827 village directory, which boasted:

> "...not one adult person is a native of the village. The oldest person living in the village that was born here is not yet 17 years old."

It is difficult to imagine that in 1810, when DeWitt Clinton and the canal commissioners came here on an exploratory trip for the proposed Erie Canal, there wasn't a single person residing in what would become the Village of Rochesterville; today's downtown Rochester. Later, in 1827 Clinton, [1] wrote to Everard Peck recalling his visit:

> "When I saw your place here in 1810 without a house who would have thought that in 1826 it would be the source of such a work? This is the most striking illustration that can be furnished of the extraordinary progress of your region in the career of prosperity."

Not everyone shared the governor's enthusiasm for Rochester. In 1826, Amos Eaton (1776-1842), the "Father of New York Geology" and the founder of Rensselaer Polytechnic Institute in Troy (originally named the Rensselaerian School after its patron Stephen Van Rensselaer) led a geological expedition across the state aboard the canal boat LaFayette. Earlier, in 1823, Eaton made the first detailed geologic study of the Rochester gorge where he accurately depicted the sequence of formations in a sketch contained in his field notebook. [2] Eaton's understanding of the geology of the gorge was further advanced by the Reverend Chester Dewey. Eaton's work formed the basis for the illustration entitled "Section of Rocks on the Genesee River etc." on page 77 of Henry O'Reilly's 1838 Sketches of Rochester, and redrawn here (Figure 1) with annotations.

Returning to Eaton's 1826 field excursion, the group included Rensselaerian School students, faculty, and several dignitaries such as George Clinton, the governor's son; Asa Fitch the future state entomologist; and Joseph Henry, the brilliant young physicist who performed some of the seminal experiments on magnetism in this country and thereafter helped found the Smithsonian Institute. [3] The party arrived in Rochester on Sunday, May 14, and Asa Fitch recorded Eaton's impressions of Rochester:

> "This place Prof. Eaton says is a mere mushroom springing up in a moment and is destined to decay and fall away to nothing. He predicts that there will not be a third of the present number of buildings in the lapse of a few years; that he does not believe there is a place on earth so remarkable for its splendor and poverty.[4]"

Fifteen years later (August, 1841) Rochester was visited by the eminent and world renown Scottish geologist Sir Charles Lyell who recorded in his diary:

> "We explored the picturesque ravine through which the Genesee flows at Rochester, the river descending by a succession of cataracts over the same rocks which are exposed farther westward on the Niagara...The contemplation of so much prosperity, such entire absence of want and poverty, so many school-houses and churches rising everywhere in the woods...fills the traveler with cheering thoughts and sanguine hopes...[5]"

One can only wonder if Eaton and Lyell visited the same municipality.

Rochester was preordained for greatness, not so much by its location on the canal—a major east-west artery of commerce—but by its location at the waterfalls and gorge carved by the muddy waters of the Genesee in its head-long dash north to Lake Ontario. The waterpower, derived from the river's drop, churned water wheels that in turn drove gears, shafts and leather belts that provided smokeless industrial power. A spectrum of products for domestic, agricultural and industrial use, such as flour, furniture, edge tools, farm machinery, beer, barrels, canal boats, and fire engines were but a few of the products directly or indirectly, turned out by Rochester's many water-powered mills.

The waterfalls and river gorge are primary in the historical settlement and industrial development of Rochester and therefore geologic and human history are intertwined. Geologic events of the near and distant past laid the foundation that guided the course of human events resulting in the founding and growth of Rochester. In broad strokes, the geological-historical interrelationship can be explained by the gorge's attraction of the early settlers because of the ample waterpower. The mills that located at the falls produced goods that could not be inexpensively transported to New York City markets. It cost $100 per ton to ship goods overland, which was a huge expense for any company. The attraction of great reductions in shipping costs provided the incentive for locating a canal across the Genesee River at Rochester. Shipping costs dropped to $7 per ton once the canal was completed, giving Rochester millers and their products a ready access to eastern markets. This suddenly transformed what before the canal was a struggling enclave at the small Upper Falls of the Genesee, into a thriving, vibrant community after the ditch's completion. Had the Rochester gorge not formed and if it did not contain the rock types necessary for the formation of waterfalls, the canal may have crossed the Genesee elsewhere, perhaps farther south, and maybe Canandaigua, Avon, or Batavia would have attained Rochester's status as the major city in the region.

The topography of the region is discussed first, with an emphasis on the Niagara Escarpment and how it relates to Rochester and the Rochester gorge. This will be followed by a section focusing on the origin of the bedrock formations that are exposed in the gorge and elsewhere on the face of the escarpment. Lastly, the paper will conclude with a discussion of the glacier's effect during the Ice Age, in sculpturing the final scene, and in so doing altering the course of the Genesee River and thereby the course of our history.

THE NIAGARA ESCARPMENT

A prominent rock ridge, approximately 200 feet high, rises abruptly from the lake plain that borders the southern shore of Lake Ontario. This topographic feature was called the Mountain Ridge by the early white settlers, and later the Niagara Escarpment by mid 19th-century geologists. Although ill-defined east of Rochester, the escarpment becomes more pronounced westward forming a sharp angular feature in the Niagara River region (Figure 2).

Downtown Rochester and I-490 West, from downtown to the Spencerport exit, lie at or near the crest of the escarpment; numerous rock cuts along the way proclaim its presence. Further evidence of the escarpment's existence in the Rochester area is revealed by the sharp drop in the lay of the land north of Ridgeway Avenue and the view of Lake Ontario that northbound motorists can observe from NY-390 just north of Lexington Avenue. Art Park at Lewiston is nestled at the escarpment's base, while drivers crossing west into Canada at the Queenston Bridge can clearly see its summit a short distance north of the bridge.

The Niagara Escarpment should not be confused with Ridge Road which is 3 to 4 miles to the north. This is a much smaller ridge—composed of sand and gravel—and marks the site of a beach or shoreline feature of a high level glacial lake called Lake Iroquois, a precursor of Lake Ontario. Furthermore, the Ridge Road is just tens of feet high and only 10,000 to 12,000 years old, while the rocks that constitute the Niagara Escarpment are 420 million years old, nearly six times older than the last of the dinosaurs (Figure 3).

These two prominent topographic features did not escape the keenly watchful eye of DeWitt Clinton during his canal tour of 1810. [6] In his journal entry for Sunday July 29th, he wrote:

> "Shortly after leaving the Genesee River, we entered a remarkable road called the Ridge Road, extending from that river to Lewiston, seventy-eight miles. The general elevation of the ridge is from ten to thirty feet, and its width varies........About from three to half a mile south, and parallel with this ridge, there is a slope or terrace, elevated 200 feet more than the ridge, with a limestone top [Lockport Dolostone], and the base freestone [Queenston Shale/Grimsby Sandstone]. The indications on the ridge show that it was originally the bank of the lake. The rotundity of the stones, the gravel, and c., all demonstrate the agitation of the waters........"

The base of the Niagara Escarpment exposes red sandstone and shale (primarily Grimsby or Red Medina Sandstone). The middle part of the escarpment is made up of gray shale with relatively thin limestone beds (Clinton Group), while the upper part reveals mostly dolostone (Lockport Group). Above the escarpment's dolostone caprock is a thick shale sequence (Salina Group) that underlies the lowlands intervening between the Niagara Escarpment on the north and a smaller escarpment to the south (Onondaga Escarpment) on which Buffalo, Batavia, Avon and Honeoye Falls are located (Figure 3). In this intervening lowland flow the waters of Black Creek (east) and Tonawanda Creek (west) with the vast Tonawanda, Iroquois and Oak Orchard Swamps between them (Figure 2).

The Niagara Escarpment owes its existence to the rock sequence. One of the principles of geomorphology (study of landscapes) states that resistant materials stand out in relief. That is, any rock unit or mass that is resistant to the destructive forces of weathering and erosion will stand high, while weaker material will crumble and wear away. So it is that the resistant Lockport Group, sandwiched between the weak Clinton Group shales below and weak Salina Group shales above, came to form the crest of the escarpment through hundreds of millions of years of differential weathering and erosion. When rivers and streams eventually crossed the escarpment and cascaded down its face, waterfalls and rapids formed. These, in time, receded or migrated upstream leaving behind deep bedrock gorges notched into the escarpment. Thus did the Rochester and Niagara Gorges come into being. But before all this could happen, the underlying bedrock units had to be deposited.

BEDROCK GEOLOGY

The strata exposed in the Rochester Gorge were deposited discontinuously over a span of 20 million years beginning in the Late Ordovician Period approximately 430 million years ago, and ending in the Middle Silurian Period approximately 410 million years ago (Table 1). The total sedimentary package is about 450 feet thick and was deposited in environmental settings ranging from marginally marine intertidal to fully marine deep water. The stratigraphic column is subdivided into four major rock units (from older to younger): Queenston Shale, Medina Group, Clinton Group and Lockport Group. These units, save for the Queenston, can be further subdivided into finer scale units called formations and members, as shown on Table 2.

The Queenston Shale and Medina Group are well exposed in the lower gorge from the Stutson Street Bridge to the Lower Falls, just south of the Driving Park Bridge. The top of the 84 foot-high Lower Falls exposes the base of the Clinton Group, namely the Kodak Sandstone, a prominent gray band exposed about half way up the side of the gorge just above the red Medina Group. Early in Rochester's history this falls was known as the Lower Step of the Lower Falls (Figures 4 & 5).

At the Lower Falls, above the Kodak Sandstone, the gorge reveals nearly the entire Clinton Group terminating at the top in the lower part of the Rochester Shale. The Reynales and Irondequoit Limestones are relatively conspicuous as they jut out from the side of the gorge. They have a brownish color and are made up of thicker beds than the intervening thin bedded shale (Figure 6). The Reynales Limestone is made even more prominent by the presence of a thin (1 foot-thick) red iron ore bed, a few feet up from the base of the unit. This bed has recently been named the Seneca Park Hematite. [7] The upper part of the Reynales Limestone caps the Middle Falls which earlier was known as the Upper Step of the Lower Falls. Today RG&E operates a dam on top of the Middle Falls. The remainder of the Clinton Group is exposed more or less continuously to the lip of the High, Main, or Upper Falls just north of the Inner Loop and Conrail bridges and south of the Pont de Rennes Bridge over the river. At one time this falls was called the Middle Falls (Figures 7 & 8).

From the brink of the High Falls to the Court Street Dam the Lockport Group is exposed in the banks and bed of the river. The Lockport not only caps the High Falls, but once formed a small cascade of about 14 feet that stood where the Broad Street Bridge (second Erie Canal aqueduct) is today. This small cataract was, before canal construction, the Upper Falls of the Genesee. Over the years the change in terminology for Rochester's three waterfalls (originally four) led to much confusion. Going downstream from downtown, the original Upper Falls no longer exists. The old Middle Falls is now the High (or Main, or Upper) Falls, while the Upper Step-Lower Falls is now the Middle Falls and the Lower Step-Lower Falls is currently known as the Lower Falls (Figure 5).

Depositional Models

From the time the strata in the gorge were first examined by Amos Eaton in 1823, numerous models have been advanced to explain how the rocks were deposited. A relatively recent one, proposed and championed by Dr. Carlton Brett of the Geological Sciences Department at the University of Rochester, is the concept of sequence stratigraphy. The basic tenet of this model is that the sedimentary rocks in the gorge can be grouped into genetically related packages (called sequences), bounded above and below by surfaces that represent gaps in the rock record called unconformities. An unconformity may represent 1) a surface of erosion where rock strata have been removed when the area was above sea level, 2) a surface beneath sea level subjected to submarine erosion or 3) a surface below sea level that underwent an interval of nondeposition. An analogy may be drawn to cuts in a motion picture whereby whole scenes are eliminated and the movie spliced together again. The splice would represent an unconformity. In the field, unconformities can be recognized by surfaces that display: irregular relief across a region, clear evidence of scouring, or a horizon of dark gray, irregularly shaped, pebbles of calcium phosphate (called phosphate pebbles). Apparently calcium phosphate precipitates out of sea water only in the absence of sediment influx during times of sediment starvation.

A typical sequence begins when sea level is low. Therefore a particular region now above sea level is subject to erosion forming an unconformity. Another possibility, at this time, is that nonmarine strata are laid down at the base of a sequence above a regional unconformity. Following this period of sea level lowstand, sea level begins to rise, flooding the region. This is termed a transgression. As the shoreline parades inland, gradually flooding the previously exposed land, the transgressive sequence begins with shallow water, continental shelf, deposits that are subsequently overlain by more offshore deposits, generally limestones. At maximum flooding sediment starvation may result in phosphate nodule deposition above the offshore deposit. The upper part of each sequence typically begins with a deep water deposit, above the phosphate horizon, which is in turn overlain by successively shallower deposits (a shallowing upward sequence) as sea level falls. Eventually sea level may fall enough to expose the region to erosion, resulting in the formation of another unconformity. However, erosion may also remove portions of the underlying sequence thereby resulting in only a partial sequence preserved in the rock record. In summation, sequence stratigraphy presumes to record a rise of sea level at the start of the sequence above an unconformity or nonmarine strata, followed by a fall of sea level at the end of the sequence. The result is another unconformity at the top of the package followed by the next rise in sea level with its signatory sediments.

Recent studies of the Silurian of Western and Central New York by Brett, et. al,[8] have revealed six major, unconformity bounded, sequences in the section exposed in the Rochester Gorge (Table 2).

STRATIGRAPHY

Queenston Formation

During the Late Ordovician Period, what is now eastern North America collided with an island arc out in the Atlantic. The resulting compressive forces heaved and buckled the earth's crust, in eastern New York and western New England, forming large Alpine-like mountains. The Taconic Mountains of New York, the Green Mountains of Vermont and Berkshire Hills of Massachusetts were born. Rivers flowing west off the newly formed upland eroded the landmass, washing it away to a sea that covered the remainder of New York. Over time, sediment began to fill the marine basin and a large delta formed, first at the base of the mountains, and later across the entire state. The result was the Queenston Formation, 1,000 feet of unfossiliferous, fine grained, red, shale, siltstone and sandstone deposited at the seaward margin of this delta. Many of the beds display mudcracks and current ripples, further evidence of its subaerial to intertidal depositional setting. Only the upper 50 to 55 feet of the Queenston is exposed in the gorge, comprising the lowest strata below the Driving Park Bridge. Following deposition of the Queenston, an interval of emergence prevailed during which a major erosion surface was formed. This erosion surface, widely traceable in eastern North America, is called the Cherokee Unconformity (Figure 9).

Sequence I

Medina Group

Grimsby Formation

The Grimsby or Red Medina Sandstone represents the return of terrestrial, deltaic and intertidal deposition to the Rochester area following the erosion that formed the Cherokee Unconformity. This 50 to 55 foot-thick red, sandstone sharply overlies the Queenston, its lower portion made even more conspicuous by a 10 foot thick bed of massive sandstone. The Queenston and Grimsby together make up most of the exposures in the Rochester Gorge north of the Lower Falls, their red color a striking contrast to the gray, green and buff colors of the overlying Clinton Group shales and limestones (Figures 9, 10, and 11). The Grimsby, especially in the middle of the unit, contains numerous worm burrows and trails—one a U-shaped tube (Daedalus), and the other a corrugated, horizontal, criss-crossing, trail (Arthrophycus). These fossils, along with sedimentary structures such as wave and current induced ripples and mud cracks on some bedding surfaces, indicate a deltaic origin for these strata.

The Grimsby Sandstone is famous as an important source of fine building stone, and was quarried below the Lower Falls, early in the city's history. The stone for the first Erie Canal aqueduct over the Genesee River (1822-1823) came from the Grimsby quarried at Carthage (below the Lower Falls). The red sandstone aqueduct was narrow, leaked badly and had a sharp hairpin turn at its eastern end. When the Erie Canal was enlarged in 1836, one of the earliest projects undertaken was the building of a new aqueduct (1836-1842) just south of the old one. Today this aqueduct supports the Broad Street Bridge.

The Old Stone Warehouse (c. 1822), now restored as an office building at the corner of Mt. Hope and South Avenues, is also constructed of the "Red Medina Sandstone", probably from Carthage. However, the best quality stone came from quarries located along the Erie Canal from Holley through Hulberton, and on to Albion and Medina. From these quarries came the curb stones for Rochester's city streets, the Methodist Church at Bulls Head and other 19th century red sandstone buildings in the city but not the present City Hall on Church Street built in 1885-1889 and designed by Harvey Ellis. [9] St. Luke's Church (1824) on Fitzhugh Street, where Nathaniel Rochester worshipped, incorporates some Grimsby Sandstone in its structure. In addition to building stone, the Grimsby was also notable because salt springs emanated from it and some of these springs used to manufacture salt in Greece and Webster during the 1800s.

Clinton Group

Kodak Sandstone

The Kodak Sandstone is currently placed at the top of the Medina Group by Brett, et al, but this usage is not incorporated here. The author, prefers the conservative approach of utilizing the historically accepted nomenclature of the Clinton Group beginning with the Kodak Sandstone. This stratum of gray sandstone is about 5 feet thick, lies directly above the Grimsby, and forms a prominent stripe on the sides of the gorge downstream from the Lower Falls (Figure 11). In 1823, Amos Eaton called it the Gray Band. The Kodak caps the Lower Falls and represents a shallow water deposit, the initial transgression of the Sequence I sea. The remainder of Sequence I strata were removed by erosion that took place when sea level dropped at the end of Sequence I time.

Sequence II

Maplewood Shale

Sequence II begins with marine sediments laid down in a shallow subtidal setting, now the 21 foot-thick green Maplewood Shale. The Maplewood therefore represents the initial flooding of the Sequence II, transgressing, sea into the Rochester region. It is well exposed along the access road to the RG&E substation, down from Seth Green Drive, just west of St. Paul and Norton Streets (Figure 12).

Reynales Limestone

The Reynales Limestone is a slightly deeper, more offshore, deposit than the underlying Maplewood. Therefore the two units are interpreted as a deepening upward sequence that recorded the rise of sea level at the start of Sequence II. The Reynales is subdivided into three units or members. In ascending order, they are Brewer Dock Limestone (3 feet), Seneca Park Hematite (Iron Ore, 1 foot) and the Wallington Limestone (17 feet). The Brewer Dock is characterized by thin beds of fossiliferous limestone alternating with thin, green, shale beds resembling the Maplewood Shale below. The Seneca Park Hematite was previously known as the Furnaceville from exposures in northwestern Wayne County. Recent mapping by Dr. Carlton Brett and his students at the University of Rochester reveal that the iron ore in the Genesee Gorge is actually at a higher level than the Furnaceville iron ore in Wayne County and therefore can not be the same unit. The Seneca Park is found just below the crest of the 25 foot high Middle Falls and along both sides of the gorge downstream from this point to near Kodak Park.

The overlying Wallington Limestone was deposited in an open marine, shallow to moderate, subtidal, clear, tropical ocean. The evidence for this scenario is that the rock is coarse grained, some bedding surfaces are ripple marked, but more importantly the unit yields a rich and diverse assemblage of invertebrates, including corals. Some beds especially in the upper 7 feet are packed with masses of the large (2 to 3 inches long), smooth shelled, brachiopod, Pentamerus that when alive must have grown like "oyster beds" on the Silurian sea floor. The combination of certain dense strata packed with fossils, interbedded with some containing nodules and stringers of chert (flint) renders the Wallington Member especially resistant to weathering and erosion and therefore it forms the cap of the Middle Falls (Upper Step-Lower Falls) as well as the falls on Densmore Creek down from Densmore Road north of Norton Street (Figures 13 and 14).

The footings of the ill-fated Carthage Bridge were placed on the lower portion of the Wallington Limestone approximately 3 feet above the iron ore bed, but north of the Lower Falls and about 25 feet above it. The single arched, wooden, bridge was erected in February 1819 by an association of gentlemen including Elisha B. Strong, Levi H. Clarke and Heman Norton. The bridge was 718 feet long, 30 feet wide, had an arch cord length of 352 feet and a height of 54 feet. The bridge stood for 1 year and a day when the weight of the timber pressing unequally upon the arch caused it to collapse into the gorge.

The area between the Middle and Lower Falls was the site of much industrial activity (Figures 15 and 16). At the Middle Falls mills sprouted on each side of the river on mill races beginning above the falls and terminating just below the Lower Falls. In 1817 Elisha B. Strong, Heman Norton and E. Beach erected flour mills with four pairs of stone on the east side of the Upper Step. They were later owned by Ira and George Avery and Philip Thurber. Shortly thereafter a few more mills came into existence such as those of Charles J. Hill and Hooker and Company. In 1837 William Kidd and Thomas Paterson carried on the carpet manufacturing business here where yarn was prepared from wool. P. Foley and Company operated a paper mill on the west side and the establishment of A. Whipple and Company sawed and prepared veneer on the east side of the Upper Step by 1838.

After 1838 industrial development of the west side acreage, downstream from the Middle Falls, gradually surpassed that of the east side. The two industries of longest duration at the site (once called McCrackenville) were paper milling and furniture manufacturing, especially chairs. A road, Hastings Street, was eventually put in that proceeded north and downhill from Ravine Avenue on the west edge of the gorge, past the Middle Falls, then north and back uphill to the top of the gorge at the west end of the Driving Park Bridge (formerly McCracken Street).

By 1851 Stoddard and Freeman owned the paper mill, on the west side, that earlier was the P. Foley Company holdings while Oliver Cross' Tannery was located just north of the paper mill. The Rochester Paper Company made sheets for the newspaper industry in a 15 building complex just downstream from the Middle Falls from approximately 1875 to the turn of the century, by 1926 the buildings were in ruins. Nearly simultaneously the C. J. Hayden Furniture Company was in operation on the Oliver Cross site. Later, the Barnard and Simonds Furniture Company manufactured chairs here from approximately 1918 to 1959, thus becoming the longest reigning industry on the Hastings Street site. The Fred C. Lohmuller Furniture Co. then occupied the buildings from 1960 to 1961. Occupancy terminated with General Motors who utilized some of the buildings for storage in 1963-1964. The buildings were razed a short time after.

Upstream from the Middle Falls, near the base of the Bausch Street bridge, several industries occupied the "flats" of the Genesee. Most, but not all, of this acreage was created by fill dumped at the site primarily in the early 20th century. A glass plant was located on the west side of the river downstream from Bausch Street near the turn of the century. On the east side of the river north of the Bausch Street Bridge, a coal gasification plant was constructed in the late 19th Century. It greatly expanded in the early 20th century and eventually extended operations to the west side of the gorge but south of Bausch Street. (Figure 16A) Coal gas was produced by the destructive distillation of bituminous coal for use in heating and perhaps some lighting. The plant ceased production in the 1950s. On the west side "flats" south of the Bausch Street Bridge, but north of the gasification plant, the city's waste was incinerated and disposed of at the City Garbage Disposal Plant from the time of World War I to the 1960s.

The buried waste from one or more of the industries that once occupied the Hastings and Bausch Streets sites may be the source of the creosote now seeping from bedding planes in the Grimsby Sandstone exposed in the face of the Lower Falls.

Lower Sodus

Relative sea level dropped after Wallington deposition resulting in the deposition of shallow water, subtidal, green and purple shales of the Lower Sodus Formation. The Lower Sodus, approximately 20 feet thick, is particularly distinguished by its "pearly layers," thin (1 to 3 inch thick) beds packed with the lustrous shells of the tiny brachiopod, Eocoelia.

Sea level then rose again to deposit other formations above the Lower Sodus Shale at Rochester. However, immediately afterward, a major drop of sea level took place resulting in widespread erosion across western New York thereby bringing Sequence II to an abrupt end. The formations above the Lower Sodus were stripped away at Rochester but are still present in the Sodus Bay region. Therefore the top of the Lower Sodus is marked by a widespread, conspicuous unconformity that not only terminates Sequence II but is a major gap in the rock record where hundreds of feet of strata present in Central and Eastern New York are absent in western New York.

Sequence III

Middle Clinton Group

The Middle Clinton Group is not present in western New York due to the unconformity mentioned above. However, a narrow seaway persisted in east central and eastern New York where strata of Sequence III were deposited. These rock units will not be described as they are not germane to this paper.

Sequence IV

Upper Clinton Group

Williamson Shale

Overlying the Lower Sodus Shale are 6 to 10 feet of dark, organic rich, black to green, fissile, shales - the Williamson Formation. At the base of the unit is a very thin, phosphatic, pebble horizon named the Second Creek Phosphate Bed marking the regional unconformity. The physical and biological evidence points to a deep water origin for the Williamson Shale. The Williamson Shale contains few fossils, an indication that environmental conditions were highly stressed at the time. Species present are those that floated or actively swam in the ocean waters above the bottom. Therefore Williamson sediments accumulated in relatively deep water that was stagnant and oxygen-starved. Only a sparse bottom dwelling population, if any, could dwell in these anoxic waters. Higher in the water column oxygenated conditions prevailed and therefore a thriving community of floating and swimming organisms was able to flourish. When these individuals died they slowly slipped into the murky, black, bottom muds adding their organic matter to what was already there. Some of these were preserved as fossils such as the strap-like or jig-saw blade-like graptolites, whose remains blanket some of the bedding plane surfaces in the Williamson Shale.

Therefore, the Williamson represents a rapid rise of sea level commencing with the Second Creek Phosphate Bed. The Williamson accumulated at a time when sea level was at its highest point in the Silurian Period of North America. Toward the end of Williamson time sea level began to fall resulting in a shallowing upward sequence at the top of the unit.

The Williamson and underlying Lower Sodus Shales are exposed on the east side of the gorge north of the Middle Falls and on the west side north of the Rose Garden.

Irondequoit Limestone

About 18 feet of dense, fossiliferous, Irondequoit Limestone sharply overlies the Williamson. The lower 9 feet (the Rockway Member), are fine grained and were deposited in relatively deep water when sea level rose rapidly once again. After this event, sea level fell sharply terminating Sequence IV and producing another regional disconformity.

Sequence V

Sequence V commences with the upper 9 feet of the Irondequoit Limestone, the Model City Member. This member which sharply overlies the Rockway, is a coarse grained limestone, and contains an abundant and diverse faunal assemblage. The coarse lithology and abundant fossils are consistent with the inference that the Model City Member was deposited in shallow water. This conclusion is further strengthened by the presence of small mound-like reefs or bioherms near or at the top of the unit composed of algae as well as bryozoans ("moss animals"). The Model City Member records the early phase of sea level rise at the start of Sequence V.

The Irondequoit Limestone is exposed in the upper part of the gorge walls near the Lower Falls. In addition it is found on the west side of the gorge, just above the river, upstream from the R G & E Dam on the Middle Falls (Figure 17), and on the east side of the gorge north of the Middle Falls.

Rochester Shale

The Rochester Shale is approximately 90 feet thick and makes up nearly all of the gorge walls from the level of the river, above the Middle Falls, to the top of the High (Main) Falls. It comprises all of the rock visible in the gorge below Brown's Race at the newly established High Falls Historic District Park. On the gorge's east side the Rochester Shale is well exposed in the banks from river level to a few feet below Upper Falls Park. The brownish colored strata at the very top of the gorge belong to the overlying Decew Formation of the Lockport Group (Figure 18).

The lower 20 or so feet of the Rochester Shale is highly fossiliferous containing a rich diversity of marine invertebrates including corals, brachiopods, clams, snails, cephalopods, trilobites, and relatives of starfish and sea lilies known as cystoids. Cystoids had a long, flexible, jointed stalk, or stem by which they attached to the sea floor. This stem was in turn crowned by a subrounded body, about the size of a chestnut, bearing a circle of tentacles on its upper surface. The entire organism was sheathed in a skeleton of small, but hard, durable, polygonal, plates made of calcium carbonate.

The hundreds of invertebrate species found in the lower Rochester Shale combined with the fine grained shale and thin limestone beds in which they are found, indicate deposition in warm, well oxygenated, normal marine waters of intermediate depth. The lower Rochester is therefore transitional in bathymetry from the shallow water upper Irondequoit Limestone below to the deep water deposits of the middle Rochester Shale above.

In the past the classic locality for study of the lower Rochester Shale was along Densmore Creek, upstream from Norton Street, east of Culver Road. The unit was exposed above a small cascade over the Irondequoit Limestone. However, a concrete trough or flume was constructed on top of the Rochester Shale thereby rendering it inaccessible. Small exposures of the lower Rochester Shale may be seen along the south side of the Keeler Street Expressway (NY 104), just west of the Portland Avenue bridge, and along I-390 at the Ridgeway Avenue bridge.

The succeeding 20 feet of the Rochester Shale are nearly destitute of fossils. In addition the rock is a dark, organic rich, mudstone and shale. This subunit probably represents the deepest water conditions that prevailed during Rochester Shale time but not quite as deep as those that prevailed in Williamson time.

The ocean gradually shallowed again as the dark, low faunal diversity, mudstone discussed above, passes upward into lighter colored more fossiliferous shale and thin limestone beds of the Burleigh Hill Shale Member. The Burleigh Hill forms a conspicuous bulge in the middle portion of the east wall of the gorge just downstream from the High Falls (Figure 18). A second deepening event is recorded by the uppermost 25 feet of the Rochester Shale. This sedimentary package is characterized by uniform, thin (1 to 2 inch thick) beds of dolostone and shale of the Gates Member. The dolostone beds have an internal structure that suggests deposition from storm generated events such as hurricanes. The Gates is characteristically even bedded, almost banded, like the stripes on the American flag. This feature is well displayed in the upper part of the gorge at the High Falls, and also in the rock cut for the entrance ramp to I-390 South from Lyell Avenue (NY 31) westbound. The brink of the High Falls today is at the top of the Gates Member.

Lockport Group

The Decew Dolostone forms the base of the overlying Lockport Group (as used herein; see comments under Kodak Sandstone) although it should be pointed out that very strong arguments can be made for placing it at the top of the Clinton Group. Be that as it may, the Decew, which once capped the High Falls, was probably deposited in shallow water. Therefore, it represents the top of the shallowing upward sequence that began in the underlying Gates Dolostone Member. Sea level continued to fall after the Decew was deposited exposing the region once again to erosion. Thus an unconformity was produced, on top of the Decew, terminating Sequence V. The Decew is characterized by a distinctive pattern of convoluted and contorted bedding that gives the unit a "ball and pillow" or rounded, concretionary appearance especially on well weathered, vertical surfaces. This distinctive bedding has been called enterolithic structure by geologists and it can be traced west to the Niagara Gorge and into Canada. This internal structure was probably caused by flowing and slumping of the still unlithified Decew sediment, perhaps triggered by a large earthquake that shook the area one day during the Middle Silurian Period 420 million years ago!

The Decew weathers to a distinctive tan or buff color which can be seen in the uppermost 6 to 10 feet of strata in the gorge above and just downstream from the Main Falls (Figure 18). It is also well exposed in cuts on the Inner Loop, along I-490 west from downtown, and at the Lyell Avenue (NY 31) interchange with I-390.

The Decew once fomed the brink of the High Falls. However, between 1913 and 1919, under a P.W.A. (Public Works Administration) project for flood abatement and protection, the river bed was lowered from a point upstream from Broad Street to the brink of the High Falls. The blasting of the High Falls lowered it approximately 10 feet and removed the Decew Dolostone caprock from the lip of the falls (Figures 19 and 20). A second P.W.A. project from 1936 to 1938 deepened the river once again to install a new dam at the Central Avenue Bridge which today can be seen at the ustream side of the Inner Loop Bridge over the river. [10] Today the High Falls is approximately 80 feet high by direct measurement and according to elevation data supplied by R.G.&E., not 96 feet as stated by Henry O'Reilly in his 1838 Sketches of Rochester and quoted in countless publications ever since. Compounding the confusion of the falls' height is the questionable accuracy of O'Reilly's original figure.

Brown's Race was blasted through the Decew Dolostone and upper Gates Member of the Rochester Shale late in the Fall of 1817 by Francis and Matthew Brown. [11] Thomas Mumford was apparently also involved in the undertaking. [12]

Myron Holley, one of the canal commissioners, contacted the Browns requesting information on the cost of constructing a canal through limestone (at that time the term dolostone was not used, both dolostones and limestones were called limestone). Their response, reproduced below, is interesting in terms of the length of time consumed and the materials used in blasting the race. It also points out the lack of detailed knowledge possessed by the canal commissioners on the cost of blasting a canal through rock. Keep in mind that construction of the Erie Canal began July 4, 1817 at Rome, NY, in soil. [13]

Gates, Genesee County, January 1st, 1819

Myron Holley, Esquire,

Sir,

Your letter, of September last, requesting information respecting the cost of making a canal, at the Falls on the Genesee River, which we were then engaged in, to supply our mills, factory, & c. was duly received. We should have noticed the contents of that letter immediately, but did not complete the work until late in the fall, so that we could not ascertain the cost accurately until now. We have given below a statement of the different items, in the expense of making the canal, that you may see the nature of the cost, in effecting works of this kind,

Men's labour 1535 days at 62 1/2 cts.	$ 959.37
Team's labour 312 do. 50 cts.	156.00
do. by contract	100.00
Masons work, by contract, laying dry wall	55.00
Blacksmith's bills repairing tools, & c.	142.43
13 kegs of powder, at $14	182.00
Tools worn out and destroyed, say,	25.00
Use of carts and waggons, [sic]	40.00
Subsistence for men 16s. per week, the common price for boarding,	435.00
Subsistence for teams, at 16s. per week	90.00
Add for the work done by contract, on a part of the canal, the nature of the work the same,	1300.00
Superintending 6 months, say	383.39
Amount of the whole expenditure	$3868.19
The length of the canal now finished is 74 rods, through limestone, at $5227 [sic-$52.27] per rod,	$3867.98
The width with perpendicular banks is 30 feet, the average depth 5 1/2 feet, 7448 cubic yards, at 52 cts	$3872.96

It will be proper to observe, that in making this canal, the stone suitable for constructing buildings and other uses, were removed at considerable distance and piled: that opening the bank and constructing guard gates for two miles; also the fragments unfit for use in building, have been removed to fill up and make a street on the bank, the expense of all, which is included in this estimate. We do not hesitate to say, in our opinion, a canal of 30 feet wide and 5 1/2 feet deep, may be worked through any limestone quarry known in this country, for $16,000 per mile.

We are, respectfully,

Your obedient servants,

MATTHEW BROWN, Jr.
FRANCIS BROWN.

By 1818 several mills were in operation on Brown's Race and with the opening of the Erie Canal to the west side of the Genesee River, in 1823, Brown's Race enjoyed the fruits of the initial boom years. Many industries flourished here and by 1879 Brown's Race generated 3,760 H.P (Figures 21 to 26). Francis and Matthew Brown rebuilt, in 1818, the first and original Harford Mill which stood on the tract in 1807, renaming it the Phoenix Mill. One third of the building still stands, formerly the Lost and Found Tavern, later Whispers and now the Public House (Figure 25). For details of Brown's Race mills and industries the reader is referred to City Historian Ruth Rosenberg-Naparsteck's "Frankfort: Birthplace of Rochester's Industry" (Rochester History Vol. L., 1988, No. 3).

An ancillary, yet interesting structure to Brown's Race is Warham Whitney's fine stone warehouse. Built around 1828 it still stands at the corner of Brown and Broad Streets, fronting on Warehouse Street. The back of the building (Broad Street side) butted against Warehouse Basin, (later changed to Mumford Basin) on the old Erie Canal. Whitney probably built the structure to store grain for his and other mills on Brown's Race. Warham Whitney invented and constructed the first grain elevator on or near this site, circa 1830. The warehouse was later enlarged and eventually rebuilt for a malt house, which in 1871, became E. P. Parson's Malt House. [14] It may be second, only to the old Stone Warehouse at Mt. Hope and South Avenue, as the oldest commercial structure in Rochester. Its most recent occupant is RPM Auto Parts (Figure 27).

To Be Continued
[PART 2]

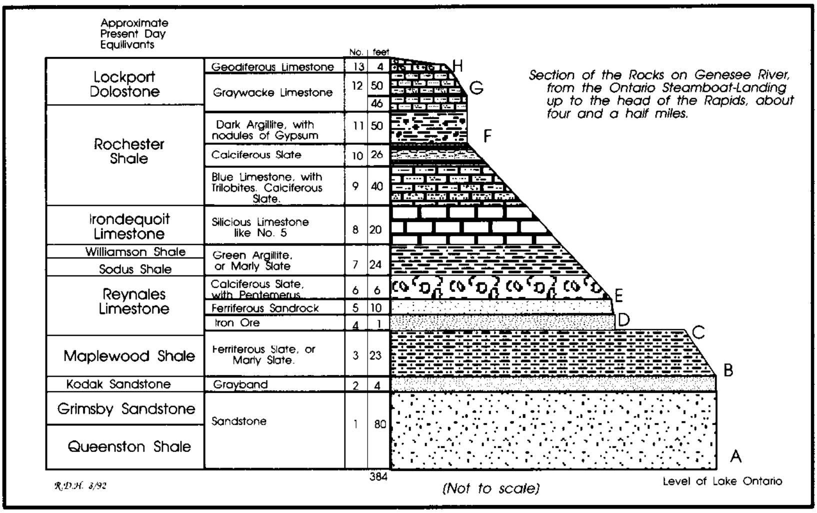

FIGURE 1: Geology of the Rochester Gorge, contrasting author's rock units with those in use 1823 - 1838.

*A to B - height of the last step (84 feet) of Lower Falls [Lower Falls]**
B to C - ascent to the upper step of those falls [Middle Falls]
D to E - height of upper step of the Lower Falls, about 25 feet [Middle Falls]
E to F - ascent up the river
F to G - height of the Middle Falls, 96 feet [High Falls]
G to H - ascent to the Rapids [old Upper Falls-base of Court Street Dam]
**Brackets are author's for current terminology*

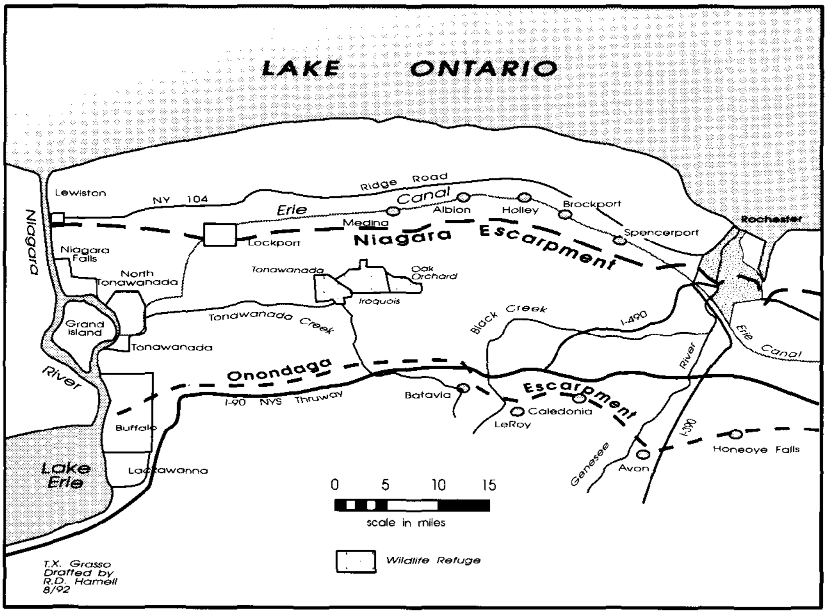

FIGURE 2: Map of the Niagara and Onondaga Escarpments in Western New York.

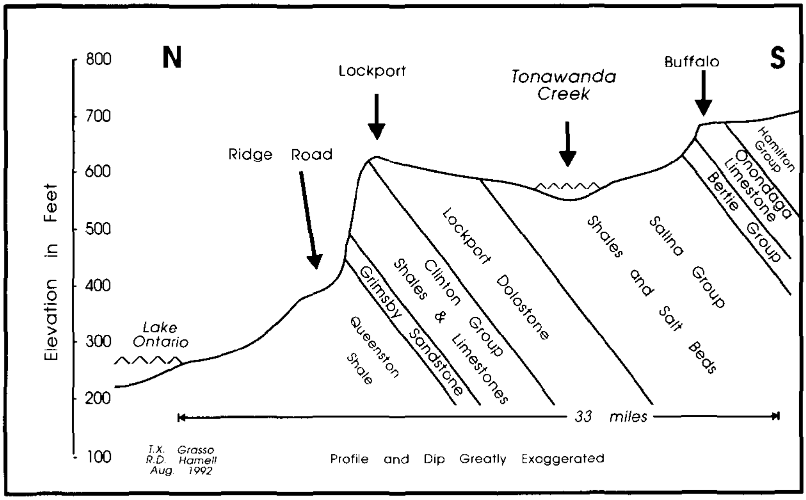

FIGURE 3: Cross Section of the Niagara and Onondaga Escarpments near Buffalo, New York.

ERA	PERIOD	EPOCH	IMPORTANT LIFE EVENTS	Major Geologic Events	YEARS IN MILLIONS
Cenozoic *Age of Mammals*	Quaternary	Holocene	Modern civilization unfolds.		0.01
		Pleistocene	Homo sapiens sapiens evolve (300,000) Homo sapiens neanderthalensis (500,000-30,000) Mastodons and mammoths	4 Major Glaciations in North America	1.8
	Tertiary	Pliocene	Primitive Hominids-Australopithecus.	Himalayas Uplifted	5
		Miocene	Widespread Grassland-Grazing Mammals diversify.		24
		Oligocene	First grasses.	Alps Uplifted	37
		Eocene	Primitive whales. First horse		58
		Paleocene	Adaptive Radiation of Mammals		65
Mesozoic *Age of Reptiles*	Cretaceous		Decline and Extinction of Dinosaurs. Angiosperms (flowering plants) evolve. Small mammals common. True birds evolve.	Cordilleran Orogeny Rocky Mts.	144
	Jurassic		Peak of the Dinosaurs. Archaeopteryx - reptile-like bird.		208
	Triassic		Dinosaurs and mammals evolve.		245
Paleozoic	Permian		Mammal-like reptiles evolve.	Appalachian Orogeny Final Uplift	286
	Pennsylvanian *The Age of Coal* *The Age of Insects*		First Reptile and True Gymnosperms. Vast "Coal" swamps.		320
	Mississippian *Age of Crinoids*			Acadian Orogeny Final Uplift Appalachian Mts.	360
	Devonian *Age of Fish*		First amphibians and insects. Sharks and modern fish evolve.		408
	Silurian *New York Salt Deposits*		Eurypterids & First land plants First land animals-scorpions	Taconic Orogeny First uplift of the Appalachians	438
	Ordovician		First jawless fish.		505
	Cambrian		Oldest fish ? (Late Cambrian)		570
Precambrian			Age of the Earth (4.6 by)	Adirondack Uplift	680 1,100 1,900 3,100 4,600

Radiometric Dates from Stanley, 1989 W.H. Freeman

Rocks exposed in the Genesee Valley (stippled)

Rocks exposed in New York State (black)

Richard D. Hamell
May 1992

TABLE 1: Geologic Time Scale

Age	Group	Sequence	Formation	Member
Middle Silurian	Lockport	VI	Oak Orchard Dolostone 100 ft.	
		VI	Penfield Sandstone/ Dolostone 65 ft.	
		V	Decew Dolostone 10 ft.	← Brink of High Falls
	Upper Clinton	V	Rochester Shale 100 ft.	Gates Dolo./Shale 25ft. Burleigh Hill Shale 25ft. Lewiston Sh./Ls. 50 ft.
		V	Irondequoit	Model City Ls. 9 ft.
		IV	Limestone 18 ft.	Rockway Dolo. 9 ft.
		IV		← Salmon Creek Phosphate
		IV	Williamson Shale 10 ft.	
				← Second Creek Phosphate
	Lower Clinton	II	Lower Sodus Shale 18 ft.	
		II		← Sterling Station Phosphate
		II	Reynales Limestone	Wallington Ls. 18 ft. ← Brink of Middle Falls Seneca Park Hematite 1 ft. Brewer Dock Ls. 3 ft.
		II		← Budd Road Phosphate
		II	Maplewood Shale 21 ft.	
				← Brink of Lower Falls
		I	Kodak Sandstone 5 ft.	
Early Silurian	Medina	I	Grimsby Sandstone 55 ft.	
Late Ordovician			Queenston Formation 55 ft.	Cherokee Unconformity

KEY - ∿∿∿ - unconformity

TABLE 2: Stratigraphy of the Rochester Gorge.

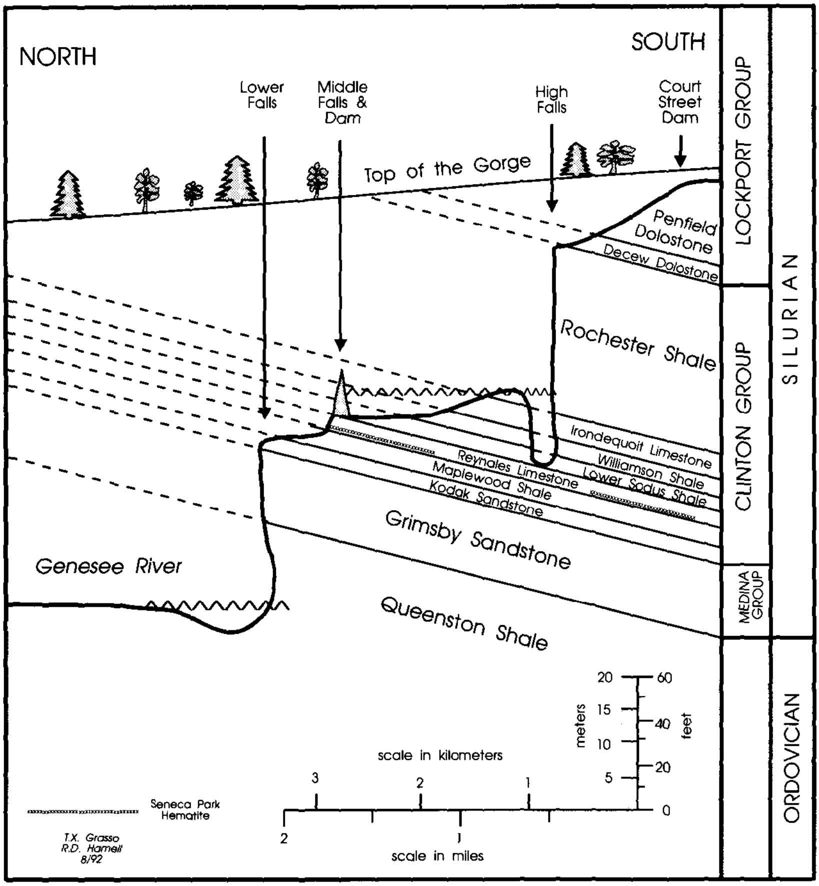

FIGURE 4: Stratigraphic Profile of the Rochester Gorge.

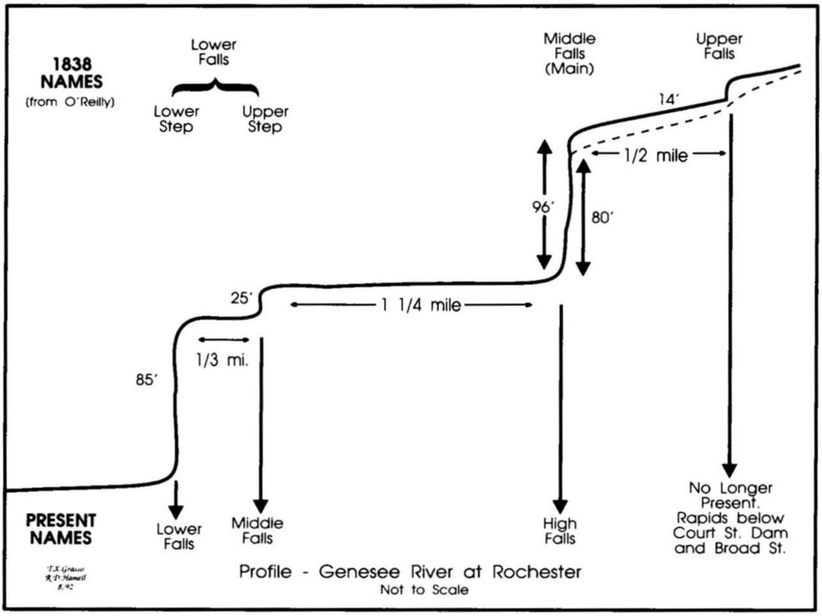

FIGURE 5: Old and current names for the waterfalls in the Rochester Gorge. Dashed line upstream from High Falls is approximate present day profile.

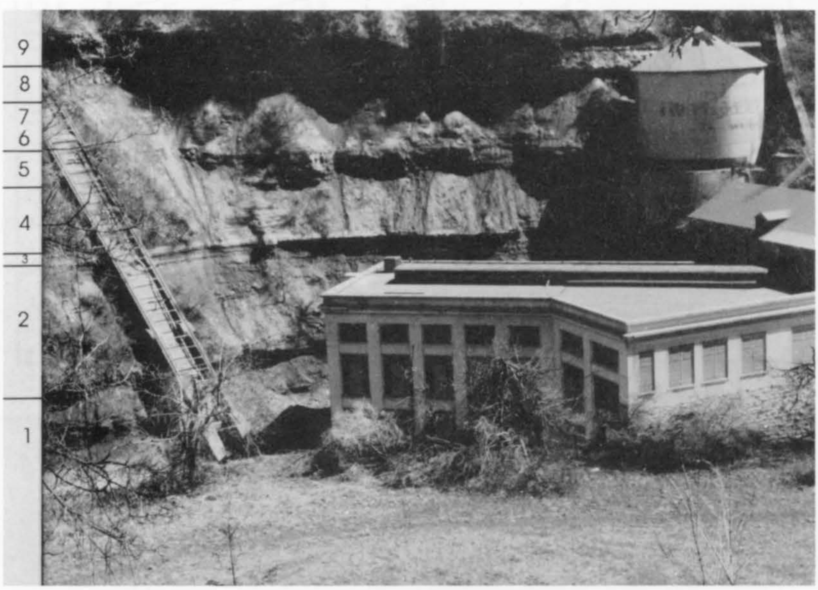

FIGURE 6: East side of gorge just downstream from the Lower Falls. Rock Units: 1 = Queenston, 2 = Grimsby, 3 = Kodak, 4 = Maplewood, 5 = Reynales, 6 = Lower Sodus, 7 = Williamson, 8 = Irondequoit, 9 = Rochester. (Bill Clar)

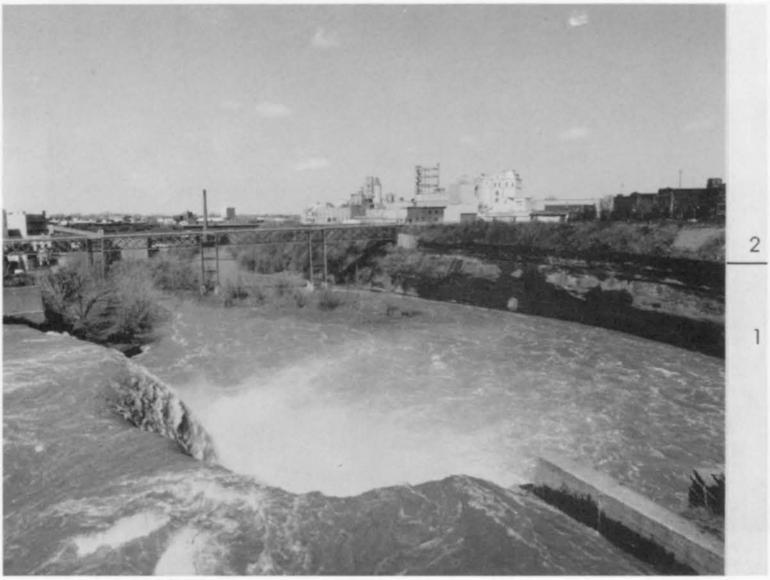

FIGURE 7: High Falls looking North above the brink to the east side of the gorge. Rock units: 1 = Clinton Group, 2 = Lockport Group. (Bill Clar)

FIGURE 8: High Falls looking south. Rock units 1 = Clinton Group, 2 = Lockport Group. (Bill Clar)

FIGURE 9: Lower Falls looking southwest showing west side of the gorge. Rock units: 1 = Queenston, a = Cherokee Unconformity, 2 = Grimsby, 3 = Kodak, 4 = Maplewood, 5 = Reynales. (Bill Clar)

FIGURE 10: East side of gorge below Driving Park Bridge showing close up of Queenston-Grimsby, contact at arrow. (Bill Clar)

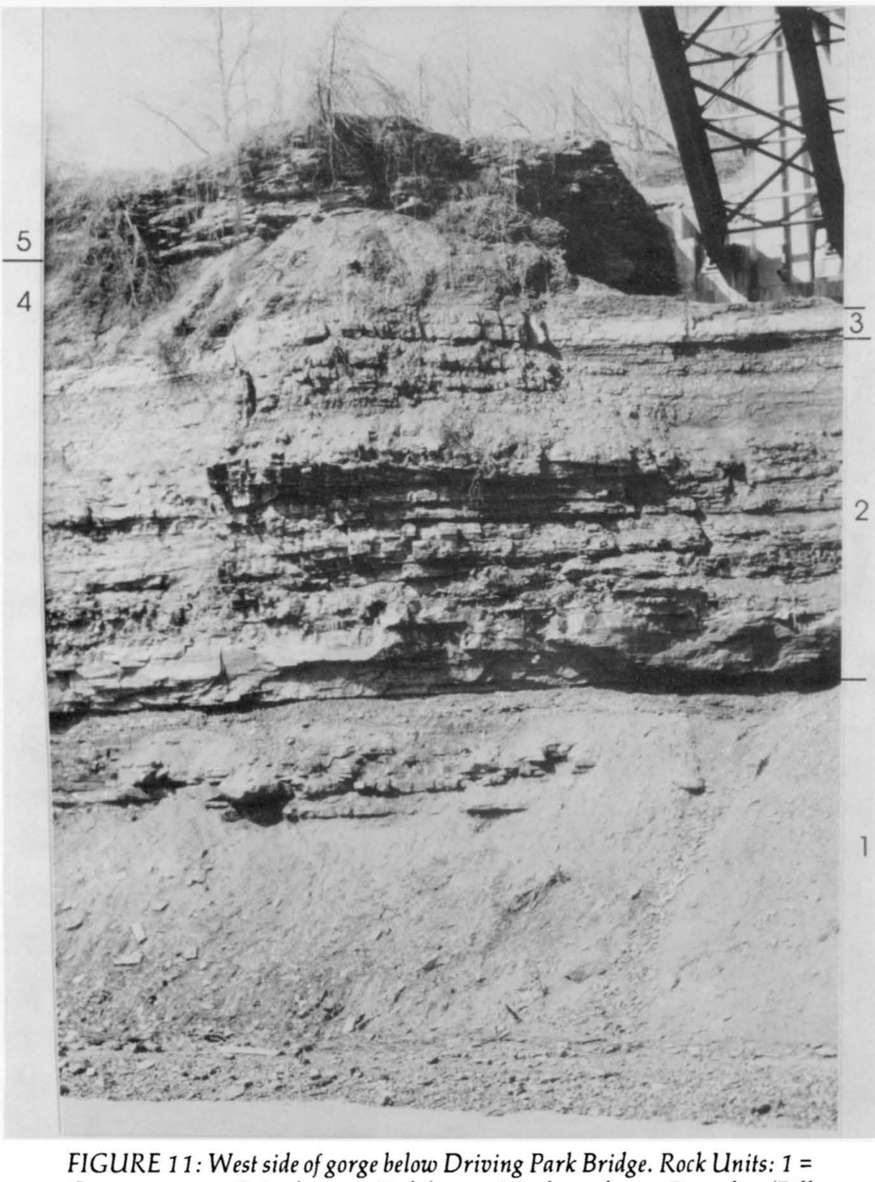

FIGURE 11: West side of gorge below Driving Park Bridge. Rock Units: 1 = Queenston, 2 = Grimsby, 3 = Kodak, 4 = Maplewood, 5 = Reynales. (Bill Clar)

FIGURE 12: East side of gorge on access road down from Seth Green Drive showing close up of Maplewood-Reynales contact at arrow. Rock Units: 1 = Maplewood, 2 = Brewer Dock, 3 = Seneca Park, 4 = Wallington. (Bill Clar)

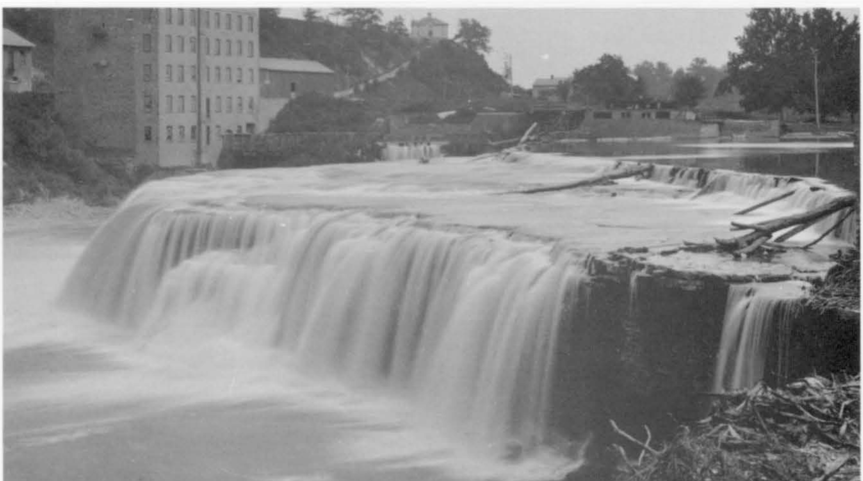

FIGURE 13: Middle Falls looking southeast circa 1875. Buildings on the east bank are probably Rochester Seamless Paper Vessel Company. (RMSC)

FIGURE 14: Middle Falls looking southwest. The footings of the RG&E Dam (1916-1917) rest on the Wallington Member of the Reynales Limestone. (Bill Clar)

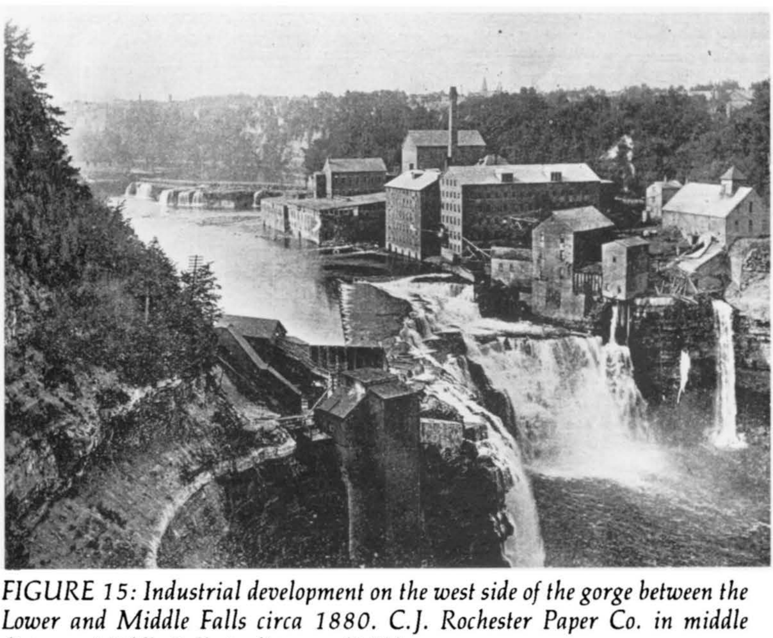

FIGURE 15: Industrial development on the west side of the gorge between the Lower and Middle Falls circa 1880. C.J. Rochester Paper Co. in middle distance, Middle Falls in distance. (RPL)

FIGURE 16: West side of gorge today, between the Lower and Middle Falls. Compare with Figure 15. (Bill Clar)

FIGURE 16A: Coal classification plant looking southwest toward Kodak Tower circa 1947. In the foreground are large gas holder tanks on the east side of the river just north of the Bausch Street Bridge. Platt Street Bridge is barely visible in the distance. The Garbage Reduction Plant is on the west side of the river just south of Bausch Street.

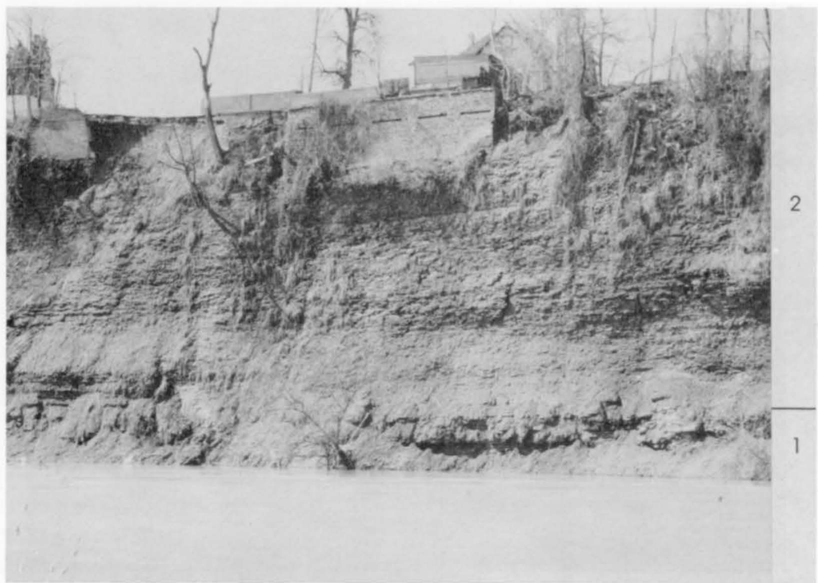

FIGURE 17: West side of gorge just upstream from RG&E Dam on Middle Falls. Rock Units: 1=Irondequoit, 2=Rochester. (Bill Clar)

FIGURE 18: East side of gorge below Upper Falls. Genesee Brewery in center and left of photo. Rock Units: 1 = Burleigh Hill Mbr.-Rochester, 2 = Gates Mbr.-Rochester, 3 = Decew Fm. (Bill Clar)

FIGURE 19: High Falls before upper ledges were removed by blasting. Looking west. Gorsline Building in distance. Nov. 1914. (RMSC)

FIGURE 20: High Falls showing rock debris from blasting. Looking west. Gorsline Building in distance. Nov. 1914. (RMSC)

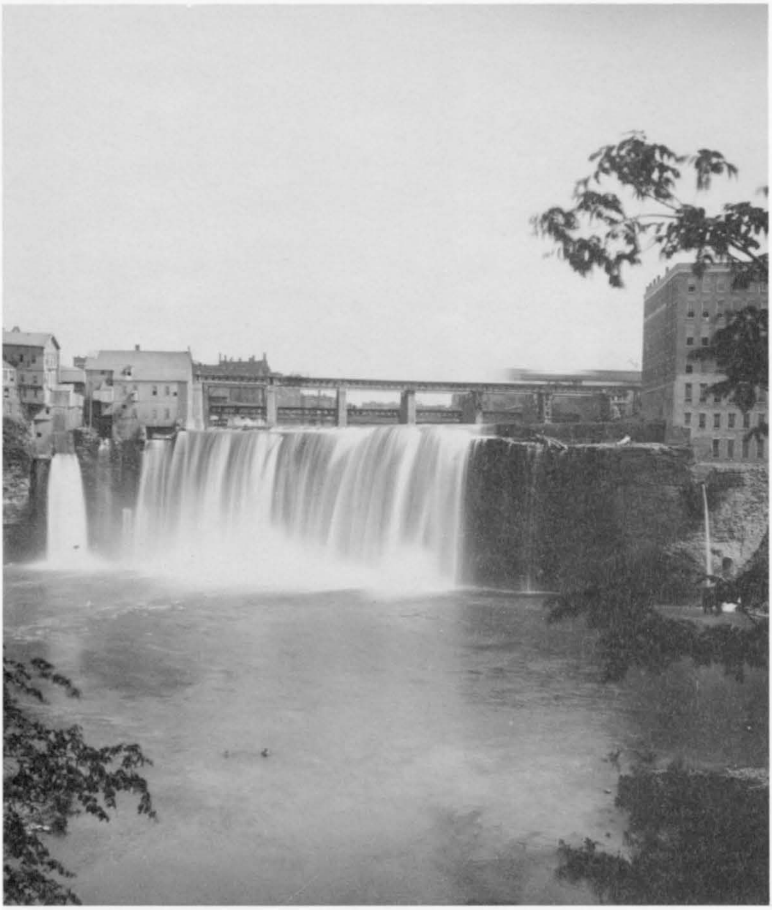

FIGURE 21: High Falls looking south about 1890. Old Gorsline Building on Brown's Island where Sam Patch made his fatal leap. Old Rochester Hydraulic Co. on east side of falls. See Ruth Rosenberg-Naparsteck, 1991, Roch. Hist., Vol. LII, No. 3. (RMSC)

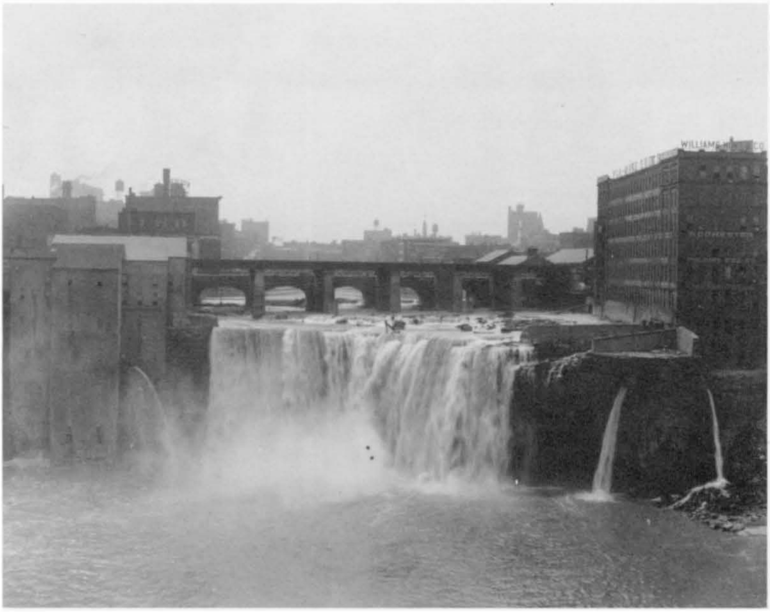

FIGURE 22: High Falls looking south about 1910. Gorsline Building on west side, Rochester Railway and Light Company on east. Decew Formation forms smaller step just upstream from brink. (RMSC)

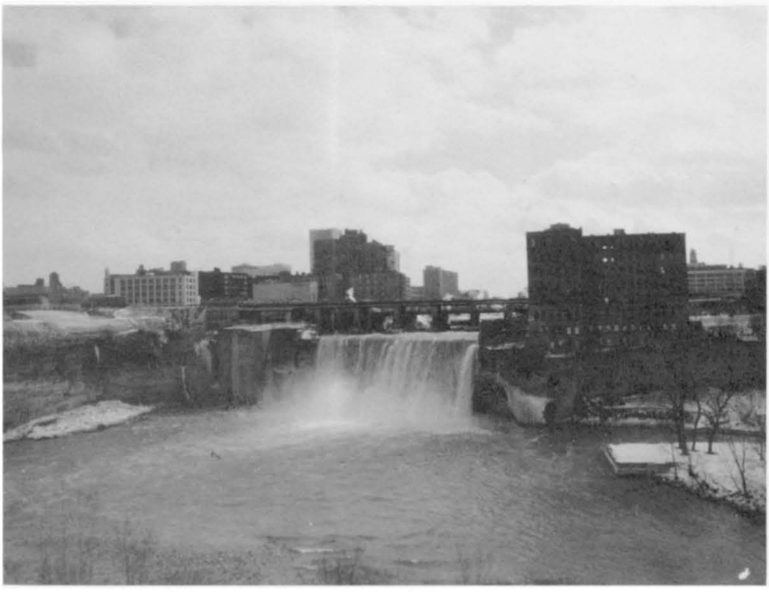

FIGURE 23: High Falls today looking south. Shell of Gorsline Building on west side, lower portion of Rochester Railway and Light Company on east. (Bill Clar)

FIGURE 24: West bank of the gorge circa 1880, looking at the backs of several mills and factories along Brown's Race. Triphammer Mill (J. Judson) is the narrow tall building at the south (left) end of the photograph. Progressing northward, in succession, is the D.R. Barton Edgetool Factory, Ezra Jones Machine Shop and Foundry, Rochester Water Works Building (Holly Pumphouse), and Granite Mill at the north edge of the photograph. (Tim O'Connell, Maps and Surveys Dept., City of Rochester)

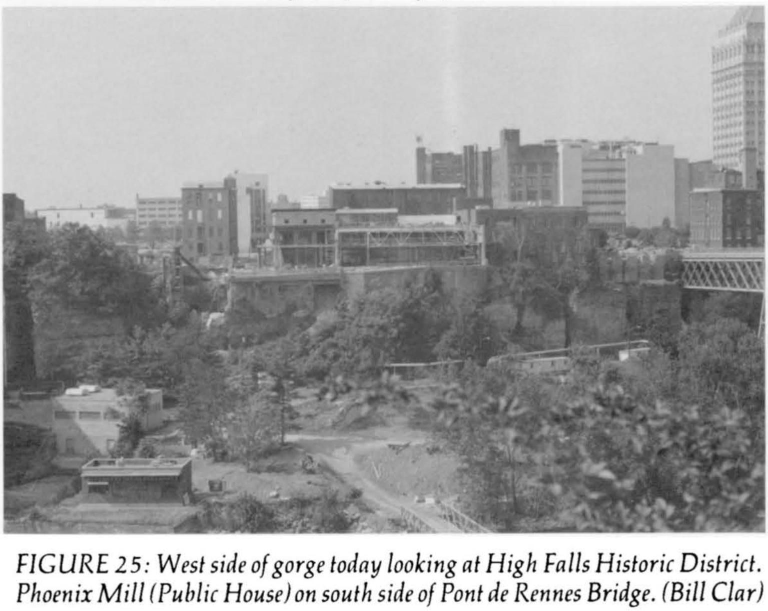

FIGURE 25: West side of gorge today looking at High Falls Historic District. Phoenix Mill (Public House) on south side of Pont de Rennes Bridge. (Bill Clar)

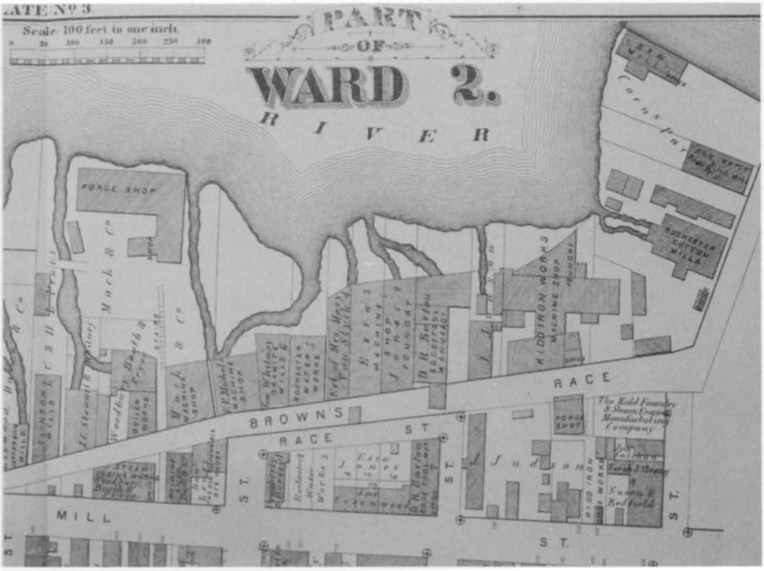

FIGURE 26: 1875 Platt Map of Brown's Race Industries. Parson's Saw Mill on the west side of the falls predates the Gorsline Building. J. Judson occupies the Selye Fire Engine Factory and Triphammer Mill. E.P. Michels Machine Shop is the former Phoenix Mill two-thirds of which was demolished for the Platt Street (now the Pont de Rennes) Bridge. Compare with Figure 24. (Tim O'Connell, Maps and Surveys Dept., City of Rochester)

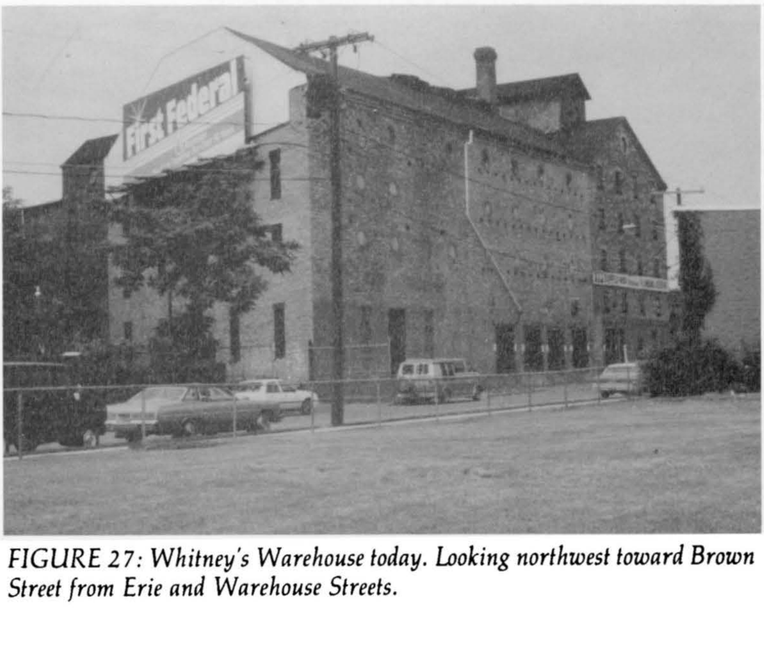

FIGURE 27: Whitney's Warehouse today. Looking northwest toward Brown Street from Erie and Warehouse Streets.

End Notes

1. O'Reilly, Henry, **Sketches of Rochester,** William Alling, Rochester, N.Y., 1838, Appendix p. 416.

2. Grasso, T.X., "Boston to Buffalo, In The Footsteps of Amos Eaton and Edward Hitchcock," **Erie Canal History and Geology,** W.M. Jordan, ed., 28th International Geological Congress Field Trip Guidebook — T169, 1989, p. 76.

3. Ob.cit. p. 49.

4. Ibid, p. 75.

5. Ibid, p. 75.

6. Campbell, W.W., Life and Writings of Dewitt Clinton, Baker and Scribner, N.Y., N.Y., 1849, p. 114.

7. LoDuca, S.T. and C.E. Brett, "Stratigraphic Relations of Lower Clinton Hematites," **Geological Society of America Abstracts** with programs, 1990, Vol. 22, p. 31.

8. Brett, C.E., W.M. Goodman and S.T. LoDuca, "Sequence Stratigraphy of the Type Niagaran Series (Silurian) of Western New York and Ontario," **New York State Geological Association Guidebook,** 62nd Annual Meeting, SUNY at Fredonia, 1990, pp. C1-C71.

9. **170 Years In One Square Mile,** City of Rochester and Landmark Society of Western New York, Inc., 1982, Tour D, p. 31.

10. Howe, H.L., "Genesee River Deepening at Central Avenue Bridge," **The Rochester Engineer,** 1936, Vol. XV, No. 6, pp. 84-87.

11. Haines, Charles, **Public Documents Relating to the New York Canals,** W.A. Mercein, N.Y., N.Y., 1821, pp 218-219.

12. O'Reilly, Henry, **Sketches of Rochester,** William Alling, Rochester, N.Y., 1838, p. 257.

13. Ob.cit. **Public Documents Relating to the New York Canals** pp. 218-219.

14. Peck, W.F., **Semi-Centennial History of the City of Rochester,** D. Mason and Co., Syracuse, N.Y., 1884, p. 631.

Back Cover: High Falls circa 1875-1880 before the Gorsline Building on Brown's Island. Parson's sawmill occupies the site. Rochester Cotton Mill on right side of sawmill. (RPL)