Reclamation of the Retsof Mine And Affected Areas[1]

by

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Abstract: The Retsof Mine, of Akzo Nobel Salt Company, in upstate New York was an underground Rock Salt Mine (NaCl) and had been in business for over 100 years. The mine was the largest producer of rock salt in the United States. On March 12, 1994, a mining section collapsed allowing water to enter the mine. The mine was eventually lost to flooding. The reclamation project included; plugging of five 1100' deep shafts, replacement of a highway bridge, creek stabilization, land reclamation of two large sink holes, demolition of a major portion of the Retsof Plant Building complex, removal and reclamation of a railroad yard and land reclamation of a 21 acre salt storage pad. The shafts were filled with a flowable fill mixture consisting of cement and coal fly ash from power generating plants. At each aquifer level a higher PSI mix was employed to seal them off from the mine. One of the collapsed areas damaged, beyond repair, the US Route 20A Bridge over Beards Creek. Reclamation consisted of demolition of the bridge and construction of a new bridge. The bridge was constructed in a manner that allowed it to be adjustable is case of further subsidence. There was concern that erosion of Beards Creek, upstream of the US Route 20A Bridge, into the collapsed areas would endanger another bridge. A grade-control structure was constructed in the creek to cut off erosion at that point and not allow it to continue upstream. This project was the recipient of the New York State Mined Land Reclamation Award for 2000 and the national winner of the National Association of State Land Reclamationalists Outstanding Reclamation Award 2000 in the non-coal category.

Additional Key Words: Beards Creek Mitigation, subsidence monitoring

Introduction

Salt Mining began in the Genesee Valley of Western New York State in the early 1880's and continued for 110 years. On September 21, 1884 Empire Salt Company began sinking a shaft to the salt bed. In October 1885, the shaft was completed and the company was reorganized to the Retsof Mining Company, named after the company's first president, William Foster (reverse spelling of Foster). By 1890, the Retsof Mine was the most successful salt mining facility in the country. The Retsof Mining Company combined with other companies to become International Salt Company in 1901. In 1923 the sinking of the Fuller Shaft was completed into the mine approximately ¾ of a mile south of the original shafts. In 1930, International Salt Company purchased the Sterling Salt Company in Cuylerville, NY. The underground workings were connected into the Retsof operations. International Salt Company was acquired by Akzo Inc in 1969, later becoming Akzo Nobel Salt Inc. Over the years, the Retsof Mine became the largest producer of rock salt in the United States with a mining area of more than 6,000 acres with a footprint of nearly 10 square miles, extracting 134 million tons of rock salt.

On March 12, 1994 the #2 Yard South (2YDS) mining section experienced a roof collapse allowing water from underground aquifers to enter the previously dry mine. On April 6, 1994 a sinkhole developed on the surface above #2YDS. The hole appeared in the Beards Creek channel centered at the upstream edge of the US20A Bridge. On April 8, 1994 the #11 Yard West mining section adjacent to 2YDS also collapsed reaching the surface on May 25, 1994. During this period the water inflow quickly increased to more than 15,000 gallons per minute. The mining operations were shifted to the upgrade northern sections of the mine and a massive effort was underway to save the mine. These

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efforts included an underground pumping station to slow the flooding and a massive surface-drilling program of nearly 30 holes to try to locate and plug off the incoming water. The efforts proved unsuccessful and all mining operations ceased on September 2, 1995 and the focus of attention was shifted to closure of the mine and reclamation of the affected areas. Planning began for a new mine site at Hampton Corners, NY located seven miles southeast of Retsof and beyond the old mine workings. Closure of the mine consisted of removal of equipment and material that would be used at the proposed Hampton Corners Mine. However, the majority of the machinery was left in the mine with all fluids (diesel fuel, transmissions and hydraulic oil, water, etc) removed from them and taken to the surface for disposal through various waste services. Storerooms and Maintenance Shops were cleared of all hazards (oils, spray lubricants, fire extinguishers, etc). The single level underground mine, measuring 6000 acres by 12 feet high, was completely flooded by late December 1995.

Objective

The objective of the reclamation program was to prepare and implement a reclamation plan that provided for closure of the Retsof Mine and reclamation of the affected areas. The plan was designed to comply with NYS DEC Mined Land Reclamation Law, all local laws, fulfill the Memorandum of Understanding agreement between Akzo Nobel Salt Inc and the NYS Attorney General and be environmentally sound, providing benefit to the community and addressing the concerns about future land uses. The reclamation program was a collection of many quite different projects including plugging of the shafts, replacement of the US Route 20A Bridge, Sinkhole reclamation, Retsof Plant demolition and reclamation, and Beards Creek Stabilization.

Methods and Results

The reclamation program included the input and involvement of many agencies. Each portion of the program had a least one and usually several agencies participating. The New York State Department of Environmental Conservation was involved in all phases. The New York State Department of Transportation was the lead agency on the US20A Bridge. The US Army Corps of Engineers was the lead agency on the Beards Creek Stabilization.

The final step of the reclamation of each of the areas was to plant grass seed in two different blends. A salt resistant blend was used at the Retsof Plant, shafts and salt storage pile areas. A traditional highway blend was used in all other areas.

A) Salt Resistant Blend:

35% Alkali Grass (Distichilis spicata)
20% Perennial Rye (Lolium perenne)
20% Kentucky Bluegrass (Poa Pratensis)
25% Creeping Red Fescue (Festura rubra)

To each 100 pounds of the above mix, we added 5 pounds of yellow sweet clover (Melilotus officinalis) for its dry weather tolerance. Instead of the traditional fiber or straw mulch, 8 pounds of winter wheat (Triticum aestivum) was added to the seed mix and seeded dry. The winter wheat germinated quickly and provided an excellent winter cover and mulch for the grass. The fertilizer was a standard 10-6-4 spread at a rate of 800 pounds per acre.

B) Highway mix:

Red Fescue – 40 pounds per acre
Kentucky Bluegrass – 30 pounds per acre
Perennial Ryegrass – 10 pounds per acre

Shafts

The Retsof Mine had five open shafts into the mine and one that had already been filled and capped (Sterling B Shaft). The Fuller Shaft was the Production Shaft. It was also the mine's west side exhaust airshaft and provided ingress/egress for personnel and materials between the surface and mine. The Sterling C Shaft was the east side exhaust air and secondary escape shaft. The Retsof #2 Shaft was the intake air and escape shaft. The hoist in this shaft was also equipped with a diesel generator so that people could exit the mine even during a total electric power failure. The Retsof #1 and Gray Shafts were abandoned shafts from previous mining operations. The Sterling B Shaft had been filled in years ago and capped with a spancrete cover. To check the condition of the fill, a spancrete section was lifted so that a visual check could be made. Verifying the condition of the fill, the spancrete section was put back in place and a one-foot thick reinforced concrete cap was installed over the spancrete cover. The five open shafts were permanently closed in a manner that sealed them off the various aquifer levels and removed hazards, both environmental and safety. The shafts

were backfilled with a with a total of 36,000 yards of coal fly ash grout, in three mixtures as follows:

Shaft Bottom Mix

313 lbs cement
1,251 lbs Coal Fly
Design Strength – 800+ PSI 28 day
Testing – 1,130 PSI average 28 day compressive strength from 2"x2" field sample cubes.

Shaft Plug Mix

190 lbs cement
2,185 lbs Coal Fly Ash
Design Strength – 400 PSI 28 day
Testing – 490 PSI average 28 day compressive strength from 2"x2" sample cubes.
7.74 x 10-6 cm/sec permeability in laboratory with constant head pressure.

Shaft Fill Mix

75 lbs cement
2,300 lbs Coal Fly Ash
Design Strength – 90 PSI 28 day
Testing – 115 PSI average 28 day compressive strength from 2"x2" field sample cubes.

The highest PSI rated mixture was used as a base at the mine level and allowed to set. The second highest was used at the water bearing levels and the lighter mixture was used for the remainder of the shaft.

After completion of the filling of each shaft, a one-foot thick concrete cap was installed on top and a plaque was embedded showing the company name, shaft name and year of closure. Grasses on all of shaft areas have recovered very well. What were industrial sites with railroad tracks and buildings are now thriving with vegetation. The only evidence of the previous activities are the concrete shaft caps.

Sterling "C" Shaft. This was an exhaust air and escape shaft. The shaft was unlined and dry. At the mine level, the west entry was sealed off approximately 100 feet from the shaft bottom using a wood retaining wall. Burlap and sandbags were placed on the shaft side to prevent seepage of the grout. The east entry was blocked using rock fill and sandbags to close off the gap to the roof. In the shaft, the lagging boards were removed every 100' to allow the flowable fill to enter the gap between the boards and rock walls. The entries were filled with the Shaft Bottom Mix over a 6-day period and allowed to set for 6 days. The entire shaft was filled with the fly ash mixtures using the Plug Mix for levels (from surface) 1063'-1020', 584'-538' and 89'-8'. The Fill Mix was used on the in-between levels. A total of 8,274 yards of flowable fill were used. Final closure consisted of demolition of the Head Frame and Hoist House Structures.

Gray Shaft. This was an unlined and abandoned shaft with a minor amount of water entering the mine through it. We did not have access to the bottom of the shaft from the mine or a safe method of ingress/egress from the surface. The first 780 cubic yards of backfill was the Shaft Bottom Mix prepared thinner to grout in the rubble pile at the bottom of the shaft. The Shaft Plug Mix was used for levels 540'- 425', 116' – 55' and 126 cubic yards mixed with clean concrete rubble from the old cap and foundations at the top. The Shaft Fill Mix was used for the in-between levels. A total of 7,364 yards of flowable fill were used.

Retsof #1 Shaft. This shaft was unlined and abandoned with a minor amount of water entering the mine through it. It had a solid permanent concrete cap on top. There was a small vent hole in the cap that had given constant but low volume methane readings throughout the years. A second hole was drilled through the cap in a water jacket so that the grout could be injected. With gas in the shaft, it was not possible to run a wire line down to measure starting or fill heights. However Shaft Bottom Mix was installed at the mine level and the Shaft Fill Mix was installed to the cap at the top of the shaft. A total of 4106 yards of flowable fill were used.

Fuller Shaft. This was the Production Shaft at the Retsof Plant and had a concrete lining. There were four entries at the mine level. A wood retaining wall was constructed in each entry approximately 100' from the shaft and lined with burlap and sandbags. Below the mine level was the bin and skip loading areas. These were filled with the Shaft Fill Mix up to the mine level. The Shaft Bottom Mix was used at the mine level and up into the shaft. The shaft was filled with the Shaft Fill Mix and a 1' thick reinforced concrete was installed on top. A total of 9197 yard of flowable fill was used. A second plaque was embedded in the concrete with the inscription: **"This mine began in 1884 and was consolidated with the Gray Mine and the Sterling Mine over the years. It was closed in 1995 after a water leak claimed it. The mine was the largest salt mine in the United States and over the years a total of 134 million tons was produced. The mine proudly claimed fourth generation miners in its talented workforce".** A headstone was also placed on the cap with the names of the 32 miners who lost their lives at the mine through out the years.

Retsof #2 Shaft. This was the intake air and escape shaft and had a minor amount of water entering into the mine through it. A wood bulkhead, lined with burlap and sandbags, was constructed at the mine level approximately 100' from the shaft bottom. The Shaft Bottom Mix was used to a depth of 963'. The Shaft Plug Mix was used between 599' and 547' and the Shaft Fill Mix in between the levels and up to the surface. The Headframe and Hoist House structures were demolished.

US Route 20A Bridge

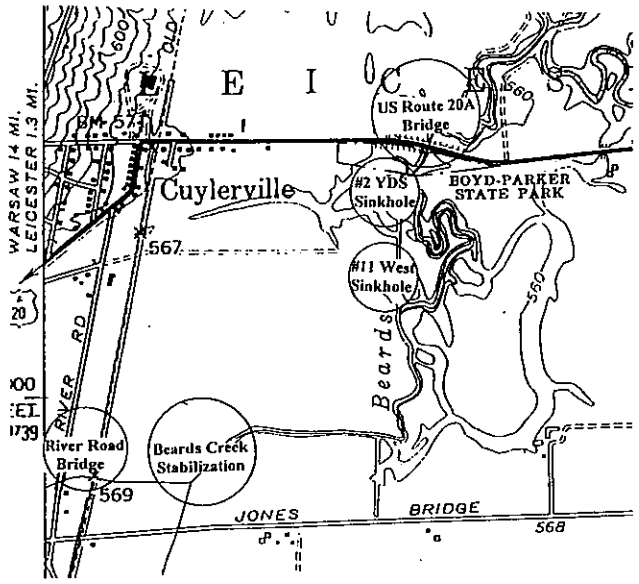

Figure 1 – Location Map

On the northern edge of the #2 YDS sinkhole was the US Route 20A highway bridge over Beards Creek. The bridge was a 100 foot long, three span, and reinforced concrete structure built in 1936. The bridge remained standing but settled more than 15 feet vertically and about 5 feet to the south toward the center of the sinkhole. The western pier was thrust eastward and broken. There were many tension cracks both in the approaches to the bridge and the land surrounding the bridge reaching out 200 to 300 feet beyond the bridge and sinkholes. US Route 20A has an Annual Average Daily Traffic of 5,150 vehicles. It had to be closed off entirely and traffic re-routed to other roads. Akzo Nobel Salt Company assumed responsibility for demolishing the old bridge and designing and constructing a replacement bridge. The NYS DOT provided review of the design and oversight and inspection of the construction. Permits were also required from the NYS DEC and the US Army Corps of Engineers. The bridge was demolished except for the foundations and piers. These were left in place and stabilized with more than 10 feet of stone fill in the creek. Vegetation was cleared, the area was surveyed and staked out, the temporary Soil Erosion and Water Pollution Control measures, such as silt fences along both sides of the creek and highway, were installed and pavement was removed that was in conflict with the sheet piling locations.

The new bridge was designed and constructed on an overlapping fast-track schedule with the following objectives: re-establish service as soon as possible including emergency access during flooding, be adjustable at both ends to allow for any future settlement, provide a 50 year life, limit the need for additional right of way, avoid the Boyd Parker Park between the sinkhole and the western approach and avoid disturbing any archeological significant areas. The new bridge is a 125' long single span structure with steel girders and concrete deck. The abutments are supported with thirty-40' long tapered, concrete filled steel piles. The approaches are conventional sloping sides except for the areas that are adjacent to the Boyd Parker Park. To avoid encroachment on the park, vertical sheet pilings were driven to depths of about 25' and anchored with continuous deadmen buried in the embankments. The total installation included more than 30,000 tons of earth, concrete and steel. To allow for future settlement, the bridge was designed with repositionable, flexible expansion bearings at both ends, extra clearance between the girders and backwalls and flexible expansion joints at both ends of the bridge. To monitor future settlement of the bridge, 8 settlement platforms and four inclinometers and piezometers were set. The new bridge was re-opened to traffic 10 months after demolition of the old bridge was started. Follow-up measurement has shown only minor lateral and vertical movement, well within the design range. The bridge and reconstructed roadways are performing exceptionably well.

Figure 2 – US Route 20A Bridge under construction.

Beards Creek Stabilization

Beards Creek and the sinkholes are located in the Genesee River floodplain. The channels and banks erode very easily. Upstream of the sinkholes, Beards Creek passes through farmland before entering an area of homes and the River Road Bridge. There was concern that channel and bank erosion of Beards Creek, into the sinkholes, would migrate upstream and endanger the River Road Bridge and possibly the culvert crossing of the southern fork of the creek at Jones Bridge Road.

To contain the Beards Creek erosion to the farmland area, a grade control drop structure was constructed in the creek approximately 1500 feet downstream from the River Road Bridge with riprap on both sides of the structure. The grade control drop structure consisted of a 5 foot high by 40 foot wide steel sheet pile weir driven deep into the creek bed. Approximately 7,000 cubic yards of material was removed from the creek and spread on the farmland. The stilling basin and the upstream and downstream banks were protected with the installation of 3,000 tons of large riprap. The existing berms along the north and south banks which protect the creek from developing re-entry erosion channels during overflow periods were moved back 100 feet on each side and extended to 1700 feet long. This preserved their purpose and moved them out of the area of potential channel widening.

Channel and bank erosion has been limited to the downstream segment of Beards Creek. Upstream of the grade control structure has shown no erosion, thus the River Road Bridge piers have been protected from damage.

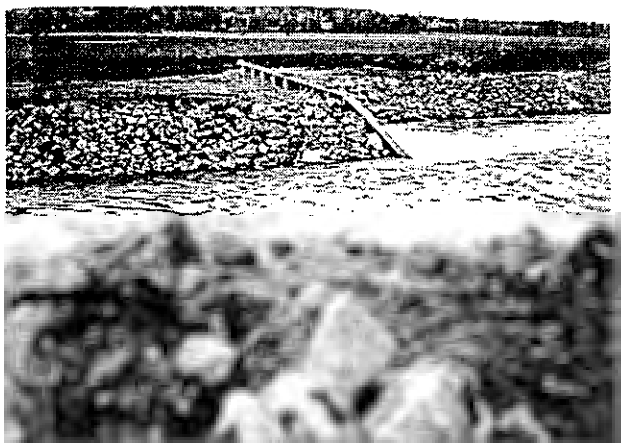

Figure 3 - Beards Creek Grade Control Structure

Sinkhole Reclamation

The two sinkholes and surrounding land to be reclaimed covered approximately 20 acres. The #2-Yard South sinkhole was about 40 feet deep with an area of 1.25 acres. The northern part of this sinkhole included the US Route 20A Bridge and Boyd Parker Park on the western section. The #11 West sinkhole was about 70 feet deep with an area of 6.3 acres and was immediately south of the #2YDS sinkhole. Adjoining the 2 Yard South sinkhole on the east side was a work area of 6.3 acres, and on the west an area of 1 acre. Adjoining the #11 West sinkhole was a work area of 5.3 acres. These are the sites that contained the drill holes, gravel roads and construction work for the efforts to save the mine. The drill holes were filled with concrete and cut off 4 feet below grade. Gravel roads were removed except for the roadway to the western side of #2YDS, which the Town of Leicester requested be left in place. The whole area was cleaned of debris, de-brushed and contoured to blend in with the adjacent area. The sinkhole areas have become wildlife ponds with excellent grass coverage to the water's edge. These have donated to the Town of Leicester. The town already owned Boyd-Parker Park adjacent to the sinkholes so these additions have expanded the size of the park.

Railroad Yard & Retsof Plant Demolition

The railroad complex consisted of the empty-car storage yard (Hill Tracks) of seven tracks and a rail-loading yard of five tracks. The total area was 10.7 acres. All of the tracks (tracks, ties, switches, plates, spikes, etc.) were removed except for the mainline tracks entering the mine site and two tracks in the empty-car storage yard. These were left in place to maintain rail access to the site for future industrial operations. The rail loading-track area passed through the buildings of the salt processing and loading stations. After the tracks were removed, demolition of the building complex began.

All structures pertaining to the processing and shipping of bulk salt were demolished leaving as much of the plant intact as possible for future industrial uses. These included the maintenance, bagging, offices, storage and utility buildings. The first step in the building demolition was to remove the asbestos. Some of the buildings had transite siding, some had asbestos roof shingles, some had asbestos floor and wall materials and most had asbestos pipe insulation. Next, individual buildings were demolished. Recyclable

Figure 4 - #11 West Sinkhole after Reclamation

materials were separated by type and shipped to the appropriate dealers. Wood, plastic, etc were taken to landfills and concrete and brick were buried on site. The largest building was the Breaker Building. It was a six story concrete building with a Head frame structure to 167' above ground. This building housed the crushing and screening complex and conveyors leading out to the rail-and truck-loading stations in overhead galleries. A total of four rail-and two truck-loading stations and the galleries that service them were removed. Also removed were transfer towers, car-puller buildings, an office building and various other outbuildings. A total of 25 buildings were demolished. Miscellaneous work included the digging up and capping of water, sewer and gas lines and the disconnecting of overhead electric and compressed air lines. The debris was removed, concrete buried, the whole area contoured and covered with 4" of topsoil.

At the Retsof #2 shaft area, the Hoist house, Head frame and a warehouse were removed. At the Sterling Side, the 'C' Shaft Head frame, Hoist house, Transformer, Wash House, Press House and Cap Storage buildings were removed.

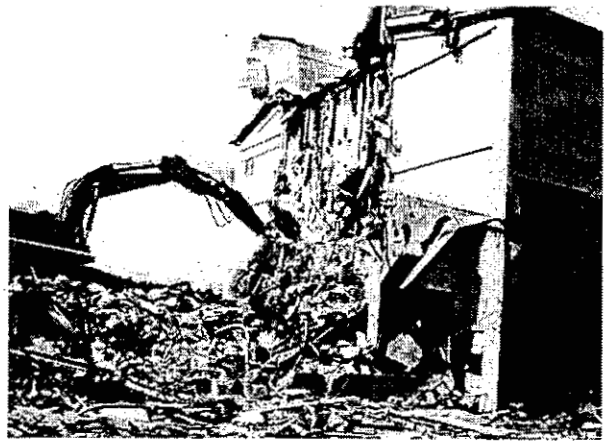

Figure 5 – Demolition of the Breaker Building

Salt Pile Reclamation

At the Retsof Plant Site there were two salt storage pads. One was 21.2 Acres and the other was 3.8 Acres. These had to be cleaned and returned to natural conditions. This project was done over a two-year period. During the first year, the small pad and about one half of the larger pad were available for reclamation as there was still a large, saleable salt pile on part of the larger pad. Silt fences were installed at the southern perimeter of the property before the water inlet into the brine pond. On the compacted clay base of the pad was a layer of hard crusted salt and dirt that had built up over the years. This layer was removed first and taken to the Sterling Site. At the Sterling Site were two 6,000,000-gallon clay lined brine storage reservoirs adjacent to each other that were part of the SPDES Controlled Discharge System. The salt pad material was placed in these. The Controlled Discharge System permitted collection of brine-contaminated water from the storage pile area and shaft water and discharge to the Genesee River at a rate so that the chloride concentration of the river did not exceed 250 mg/l of chlorides. To insure that mud from the reservoirs did not plug the discharge lines, 12"-diameter, perforated corrugated metal riser pipes were installed, wrapped in filter fabric. The installation of these pipes allowed chloride-contaminated water to drain from the reservoirs during the filling operation while holding back the insoluble material. This method allowed a reduction in spoils volume and a fully monitored NYS DEC effluent.

During the next winter season, the remainder of the salt pile was sold and during the following construction season, reclamation continued on the storage pad. The remainder of the salt crust was removed and taken to the Sterling Reservoirs. The clay base was removed to an average depth of one foot and also taken to the Sterling Reservoirs. The total amount of material removed was approximately 120,000 yards.

The conveyor foundations on the salt pads were demolished and broken off two feet below grade. The electric lines were disconnected and removed. The pad was contoured to the surrounding ditches. Next 8" of clean clay fill was added followed by 4 " of top soil.

At the Sterling Reservoir Site, the salt crust material was placed in a layer at the bottom of the reservoirs. The riser pipes were removed and the lines capped. The remaining brine water was pumped out through the SPDES disposal system. The clay material was placed on top and contoured toward the surrounding ditches. The final height was about 3' higher than the original center berm and sloped to the top of the surrounding berm. A membrane cap was added followed by 8" of clean clay fill and 4" of topsoil.

Conclusions

This project demonstrates the quality of reclamation that can be accomplished. The NYS Department of Environmental Conservation stated in a news letter: "The quality of the reclamation of the AKZO mine sets an excellent example for other mining companies to follow, though faced with significant challenges, AKZO took the initiative to develop and implement an environmentally sound reclamation plan that provided for public input and addressed concerns about future land uses, resulting in an efficient mine closure that benefits the community by allowing them to enjoy the natural beauty of the area."

The US 20A Bridge has remained open to traffic and performing well, Beards Creek erosion has been contained, the sinkhole areas have been returned to natural conditions, and the grasses on the reclaimed Retsof Plant railroad yard, building, salt pile and shaft sites areas are growing very well. On the old Sterling Mine site, Akzo Nobel Salt Inc. has donated 650 acres of land to the Genesee Valley Conservancy, so that it will remain "forever wild". The new salt mine project at Hampton Corners has been purchased by American Rock Salt Co. LLC. The shafts are complete and salt production has begun, renewing the long salt-mining tradition of the Genesee Valley.

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