A Soil Suitability/Land Use Analysis of the Historic Ketner Dam Basin in Comparison with the Elk County Comprehensive Land Use Plan

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Methods

This study made use of several types of data sources (see references and citations), including LIDAR imaging, USGS water databases, topographic maps, and geologic maps. Each source was carefully evaluated in light of the existing comprehensive land use plan of Elk County, as well as the observable characteristics of the site taken from personal observation and the collective knowledge of others who have observed the site and the ways in which it has changed over the last few decades.

Findings

LIDAR Interpretation of Ketner Dam Area

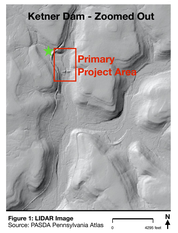


Figure 1: LIDAR Image
Source: PASDA Pennsylvania Atlas

The history of Ketner Dam is important to understanding the geography comprising the area of the old dam basin and its surroundings. The land features evident today are the result of a combination of natural and human activities. The dam was constructed by the railroad to provide water to the steam engines before their long climb up the grade between Johnsonburg and Mt. Jewett.[9]

The Buffalo, Rochester, and Pittsburgh Railroad was established through Ketner Valley sometime prior to 1911. The construction of the railroad bed certainly would have altered the surface drainage of the area, requiring that water draining from the slopes to the west of the railroad would have to be channeled into ditches that pass under the railroad grade. One such area where surface water pools and is channeled under the railroad is marked by the green star on the images.

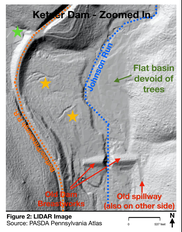


Figure 2: LIDAR Image
Source: PASDA Pennsylvania Atlas

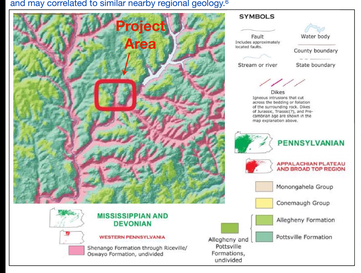
Of note in these images is the apparent change in the location of the Johnson Run stream bed. This LIDAR imagery of the project area appears to reveal topography that has resulted from the erosional and depositional cycles in the basin. Considering that the surrounding geology is mostly sandstone and conglomerates of the Pottsville Formation (Pennsylvanian), the basin is most likely composed of layers of fluvial deposits originating from the areas which feed the basin with runoff water. This soil composition is easily eroded by rain and runoff, which is supported by the evidence of topographic changes in the flattest portion of the basin, as shown in the photographs.

To the south of the old breastworks are topographic features that may be the result of the large flow of water that gushed following the breaching of the dam. Although the water levels were likely drawn down first, there still would have been a significant amount of water lying against the breastworks due to the location of the gate tower and the dam's drain. It appears that the land south of the western spillway has been eroded, with the drainage flowing toward Johnson Run south of the breastworks.

Two elongated depressions (denoted by yellow stars) have apparently formed between the railroad grade and Johnson Run, indicated a differentiation in subsurface geology. The natural trenches may be the result of breaks in the underlying bedrock. The breaks in the rock that have allowed these features to form are likely insignificant to the overall land use assessment of the area.

Geologic Map

The geology of the project area was investigated using the Geologic Shaded Relief Map of Pennsylvania[4]. This map was selected because it was the most current geologic map of the region detailing the key geologic sequences. Magnetic declination was not shown on the map, however from prior topographic map research it is known to be N10.25°W. Further research using other sources (as referenced) was necessary to determine the details of the local geology. Strike and dip data was not available for the area. The Johnson Run Syncline is approximately 2 miles NW running SW-NE. The Hebron Anticline extends SW-NE approximately 8 miles SE. of the site. Neither the syncline nor the anticline are shown on the map. The section of the valley containing the old Ketner Dam basin is of the Devonian through the Mississippian age. It is generally composed of sandstone and siltstone with some gray shale.[5] Well-cemented conglomerate is also present and may correlated to similar nearby regional geology.[6]

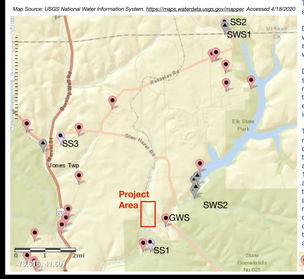


This rock is well recognized as geology favorable to hosting gas and even some small pockets of oil.[7] The higher elevations surrounding the old dam basin are of the Pottsville Formation of the Pennsylvanian Age, and at the highest elevations, the Allegheny Formation of the same period. The coals of primary importance in Pennsylvania were deposited during the Pennsylvanian Age, so it is likely that some of the rock of this area would bear incidental coal deposits. Coal in this area at elevation is probably not continuous as much of it was probably broken up during mountain building events, and subsequently eroded.[8]

The details of the local geology may give insight as to the historical condition of the water flowing through the region. It is possible that any coal, if it exists in any significant quantity, could contribute to poor soil and stream quality (via drainage) in the old Ketner Dam basin and along Johnson Run as a whole. It is also revealing that the rock of this area primarily consists of sandstone and siltstone, contributing to the apparently easily eroded and transported dam basin sediments.

Surface & Ground Water Characteristics

Map Source: USGS National Water Information System. https://maps.waterdata.usgs.gov/mapper. Accessed 4/18/2020

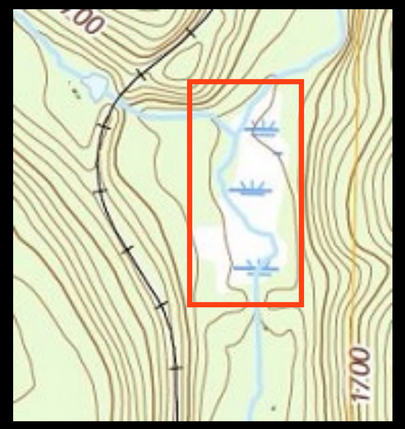


There are no water data collection sites within the project area, however surrounding sites have produced useful data:

Data from the nearest ground water site (GWS on map) was completed in 1972. The well, designated #413223078365301 was drilled to a depth of 105 feet below land surface in the Mississippian, Lower local aquifer (337MSSPL). Ground water depth was measured to be at 15 feet below land surface, or 1490 feet above NGVD29.

Data from USGS spring sampling sites (SS1, SS2, and SS3 on map, aka USGS sites MCSP3, EKSP2, and EKSP3 respectively) indicate a ground water pH level ranging from 6.4 to 6.9. These values are only slightly acidic, and nearer to neutral than was assumed to be the case for soil acidity within the projects area, and expected acidity levels in Johnson Run. COVID-19 travel restrictions make it impossible to take direct measurements within the project area at this time.

There are two surface water sites of interest for this project. They are noted on the map as SWS1 (USGS site 03027500) and SWS2 (USGS site 03026500). The site designated SWS1 to the northeast of the project area is situated so as to measure the watershed feeding East Branch Dam. This site is assumed to offer the most accurate representation of local discharge data. Daily discharge has been as high as 180 ft^3/sec, and as low as 1 ft^3/sec. The daily discharge averages at approximately 30 ft^3/sec for the period December 2019 to April 2020. The site to the east of the project area, designated SWS2 is downstream of East Branch Dam and is therefore more likely subject to discharge rates influenced by controlled water release from the dam. This site however, is the only surface water site with water quality data being recorded. SWS2 indicates an average total dissolved solids value of 50 mircosiemens/cm between Nov 2019 and March 2020. Dissolved oxygen for the same period averaged approximately 13 mg/L. Average pH level was approximately 6.7.



The primary project area is outlined here in red on the WILCOX QUADRANGLE, but the surface features, soil types, and geology of the surrounding area was also considered throughout this study. [2]

Introduction

The basin that was once the site of Ketner Dam is classified in the Elk County Comprehensive Land Use Plan as both prime agricultural land and land recommended for conservancy. However, the stream that runs through the dam basin, known as Johnson Run, has historically been known to the locals to be unsuitable to most clean water aquatic life. Only recently have trout been locally observed in the stream. This study was conducted as a re-evaluation of the dam basin soil suitability, water quality, and land use analysis as given in the county's comprehensive land use plan.

Aerial view of the primary project area. The primary project area (dam basin) is outlined here in red. [3]

Historical Description of Project Area

The dam, or what is left of it, is located in Glen Hazel, PA (Elk County). Historically, this was the site of a dam constructed to supply water to steam engines hauling lumber over the steep grade in the area. Due to torrential rains during its construction in 1911, the dam was destroyed by blasting a section of the breastworks to alleviate dangerous flood conditions. Today, all that is left are the ruins of the gate tower, spillway, and breastworks, with a stream running through the basin that was once the reservoir.[1]

Top: the old gate house control tower, Bottom left: the breastworks blasted out, Bottom right: remains of western spillway.[3]

Aerial Photograph Interpretation of Ketner Dam Area

An examination of historic maps from 1940 and 1972 helps us to understand the land use history of the dam area. Little has changed, in that nothing new has been built on or removed from the site. Nature is reclaiming the defunct dam works. The most obvious change is the large gap in the breastworks from the beaching of the dam with explosives. It is of note in these photographs that Johnson Run has apparently changed the location of its stream bed over time. A LIDAR imagery study makes this all the more obvious. The ground of the basin is most likely a layer of unlithified sedimentary fluvial deposits laid down in part while the reservoir was filled and then subsequently during occasional flooding cycles. Those soft unlithified deposits were then likely cut into by the flow of Johnson Run. A reddish-brown coloration of the stream is noticeable in the color photograph.

Figure 1 (above): View of Ketner Dam as it is today. (Source: Google Maps Android App.)
Figure 2 (right): View of Ketner Dam on 29 September 1940. Visible are the breastworks and the spillways on either side. The Buffalo/Pittsburgh railway is visible winding its way along the left side. (Source: Penn Pilot)
Both images: North is up.

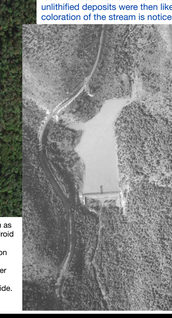
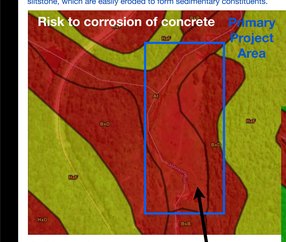


Figure 3 (below): View of Ketner Dam on 26 June 1972. The breastworks still had not yet been breached. The central section is visibly intact. The dam was not fully demolished until after a boy drowned in 1978. However, at this point in history the dam had been emptied of all but a small amount of water at the breastworks and around the gate tower. North is up.

Findings

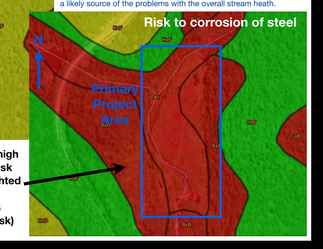
Acidic soils analysis

The Ketner Dam basin area is classified as the Atkins (At) soil type. It is a silt loam on a virtually flat grade. The soils of the Atkins type are typically acidic, and are made up of fine loamy alluvium derived from shale and sandstone.[10] This makes sense in light of the geologic analysis of the site, which indicates the primary rock units of the area are composed of shale, sandstone, and siltstone, which are easily eroded to form sedimentary constituents.



The soil survey suggests that the soil condition in the project area is acidic, perhaps as low as pH 4.4. The soil acidity level not only is such that it would not only be unsuitable for agriculture, it would also be considered a high risk to both steel and concrete. It is interesting to note that Ketner Dam probably would not be built today given our understanding of environmental science and the conditions that can have an adverse effect on building materials. It is also of note that had the dam been built, it would have probably had limited longevity due to the acidic effects of the soil (and therefor the water) in the dam. The historical image of the western spillway (center-bottom-right) shows evidence of acidic damage to the concrete by apparent sepage of runoff water through the concrete from the slope to the west.

The stream running through the old dam basin has also been apparently affected by the soils through which it flows. Historically, locals have known Johnson Run to be unable to sustain much aquatic life. The soil conditions through which the stream flows are a likely source of the problems with the overall stream heath.



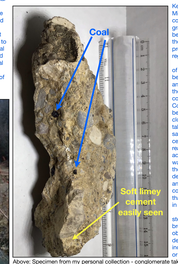
Onsite Reconnaissance of Ketner Dam

The old dam basin surface layer is primarily composed of discolored unlithified fluvial sedimentary deposits. The basin is marshy over approximately 50% of its area, especially seasonally. Vegetation consists mainly of scrubby grasses that help keep the unlithified sediment in place during flooding. This is due in part to the soil condition and its apparent inability to support other types of vegetation. Johnson Run is a small meandering stream that has historically been unable to host aquatic macro-biota apart from rust colored crayfish. Today, some trout have been observed to the south, nearer to to where the stream empties into the East Branch Clarion River. Evidence of the gradual movement of the stream's path is obvious on close inspection of current meanders and the structure of point bars. Topography surrounding the basin show that it is the natural collection point for surface drainage. Slope stability does not appear to be a serious problem in much of the topography surrounding the basin, except along the east wall of the eastern-most spillway (not shown), where slope creep combined with the degradation of the concrete is forcing a section of the spillway wall to lean inward.

The section of the valley containing the old Ketner Dam basin is of the Devonian through the Mississippian age. It is said to be generally composed of sandstone and siltstone with some gray shale. Some incidental coal is also likely to be present in the higher elevations surrounding the basin.[11] Well-cemented conglomerate is also present and may correlated to similar nearby regional geology.[12]

Inspection of the basin confirms the presence of thick layers of sandy sediments. The stream bed and beaches are mainly boulders, cobbles, and pebbles overlying sandy sediments. Much of the rock is discolored, probably due to the iron content and acidity of the water and soils. Conglomerates of any significant size appear to be few and far between. This makes sense on close inspection of a sample of conglomerate taken from the Johnson Run stream bed. The sample shown in the figure to the right is cemented with an apparent soft limey mud that reacts vigorously to a drop of weak hydrochloric acid. Given the acidic nature of the soils and water in the basin, most of the cement holding the conglomerate rocks together probably decomposes quickly leaving only the cobbles and pebbles behind. Some of the acidic contamination may come from the incidental coal that must be present. Bits of coal are easily seen in the sample shown.

Portions of the concrete construction and steel supporting elements of the remnants of the breastworks, spillways, and control tower show obvious signs of advanced deterioration. These details line up well with the soil analysis, which indicated this site would not be suitable for steel or concrete construction.



Above: Specimen from my personal collection - conglomerate taken from streambed of Johnson Run approximately 1600 feet south of the old breastworks. Note the specks of coal present in the sample.
Right: Old control tower in Ketner Dam basin.[1]

Conclusions

The Comprehensive Land Use Plan for Elk County classifies the Ketner Dam area as prime agricultural land of statewide importance. This classification is not supported by the findings of this study. The combination of geologic, soils, and ground water data, along with historic photographs and LIDAR imaging revealed the basin to be a local flood plain with acidic soils. The plan also suggests that the area would suitable for conservancy, which may be supported by this research. One person interviewed who remembers the dam and stream as it was 50 years ago remembers when Johnson Run ran red and polluted. This is apparently not so much the case today, and some claim to have even observed that trout are beginning to populate portions of the stream. It is entirely possible that natural sources of contamination have been weathered and largely removed from the basin, leaving a naturally improving environment that will one day be much healthier than it is today and has been in the past.

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