# INNOVATION ENVIRONMENTAL PARK

## GEOLOGY AND HYDROGEOLOGY REPORT

PREPARED FOR

## T. MIMS CORPORATION

100 S. KENTUCKY AVENUE, SUITE 215

LAKELAND, FLORIDA 33801

PREPARED BY:

T.M. (Mike) Gurr, P.G.

October 2009

Gurr Professional Services, Inc.
Environmental Consultants

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## GEOLOGY AND HYDROGEOLOGY REPORT

### Topography and Drainage

The site lies in the Central Florida Phosphate District in southwestern Polk County in the Polk Upland physiographic province. The pre-mining site elevations in the 1950's were approximately 160 feet above mean sea level (MSL), dropping in elevation to the north and south on the site to 140 feet MLS or less northward toward the North Prong of Alafia River drainage basin and southward towards the South Prong Alafia River drainage basin (G-1). The Alafia River watershed drains westward and empties into Tampa Bay at Riverview, Florida in Hillsborough County.

Most, if not all, of the site has been mined and used for phosphate mining waste clay disposal. Most of the site is elevated above the pre-mining topography as a result of the waste clay disposal. Due to the age of the settling basins, the overburden spoil piles from the prior mining are protruding above the settling waste clay. Current site elevations range from approximately 190 feet MSL on the crest of the highest waste clay dam near the center of the site to a low of less than 160 feet to 145 feet MSL in the post mining drainage ways. The post mining / reclamation drainage is similar to the pre-mining drainage.

### Geologic Setting

The geologic system beneath the site and the majority of Polk County consists of a thick sequence of carbonate rocks overlain by a sequence of unconsolidated sand, silt, and clay deposits, which has a minimum thickness of about 5,300 feet at Mulberry.[1] The geologic formations dip toward and thicken to the south-southwest and consist of Tertiary (Paleocene) to Quaternary (Holocene) sediments (G-2 and G-3). The formations in Polk County dip at low angles and thicken to the southeast, south and southwest, from the north-central portion of the county (the Green Swamp area north of Lakeland) as a result of the subsurface structural feature referred to as the Ocala uplift.[2]

The site lies in the Central Florida Phosphate District. Underlying a thin layer of surface sands and clays (overburden - ten to 50 feet in thickness) is the phosphorite-rich clastic portion of the Peace River Formation, i.e., the Bone Valley Member which is the stratum mined for phosphate and is locally referred to as "matrix" (G-4). The mining zone or "matrix" is generally less than 40 feet in thickness and consists of approximately equal parts of phosphate sand and gravel, quartz sand, and various clay and silt sized particles. The sediments that comprise the minable phosphate zone were deposited in a beach or alluvial (riverine) environment between 4 and 6 million years ago.[3]

### Aquifers

The site lies in the Southwest Florida Water Management District (SWFWMD). The hydrogeologic units underlying the study area consist of the surficial aquifer system (SAS); the intermediate aquifer system (IAS) or intermediate confining unit; and the Upper Floridan aquifer (FAS), the middle confining unit

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[1] Spechler, R.M. and Kroening, S.E., 2007, *Hydrology of Polk County, Florida,* U.S. Geological Survey Scientific Investigation Report 2006-5320, p 13.

[2] Stewart, Herbert G. Jr., 1966, *Ground-Water Resources of Polk County,* Florida Geological Survey, Report of Investigations No. 44, p 48.

[3] Cathcart and others

(MFCU), and the Lower Floridan aquifer (LFAS).[4] The aquifer units dip south southwestward off of the subsurface structural feature referred to as the Ocala Arch (G-2, G-3).

The hydrology of the SWFWMD region and this portion of Polk County generally consists of three aquifers as follows:

**Surficial Aquifer System (SAS):** The surficial aquifer system (SAS) is the upper most water-bearing zone throughout Florida and is unconfined. The upper surface of the SAS is contiguous with the water table, which is just below the land surface. The surficial aquifer ranges in thickness from a thin veneer of sand to in excess of fifty feet. The sediments comprising the surficial aquifer range from undifferentiated sands, clay and shell. The surface is generally quartz sand, which is generally uniform throughout the unit, which grades to clay with depth as the surficial aquifer system approaches the upper surface of the intermediate aquifer system.

Rainfall is the principal source of recharge to the surficial aquifer system. The water table generally rises to within five to ten feet of the land surface, depending upon the season of the year (closest to the surface in the rainy season and vice versa in the dry season). The water table is generally exposed along river cut banks or is at land surface within the low-lying swampy floodplains and the adjacent lowlands. The surficial aquifer is a contributor to the base flows of streams and drainages in the region. The surficial aquifer generally drains towards the rivers except in the karstic or sinkhole regions where drainage or groundwater flow in the SAS is downwards to the lower aquifers.

The SAS is an unconfined aquifer and lacks the protection of impermeable barriers to prevent contamination from surface spills, underground leaks or waste disposal activities. Throughout much of Florida and especially in Central Florida and Polk County the SAS is used to supply residences and livestock with a low volume supply of water.

**SAS Site Vicinity:** The surficial aquifer in the vicinity of the site generally lies within 5 to 10 feet of the land surface. The surficial aquifer occurs in the upper sandy sediments. The surficial aquifer is a low yield aquifer that is generally used for limited agricultural water supplies for livestock, lawn irrigation and very limited private water supplies. The pre-mining SAS at the site was approximately 40 to 70 feet in thickness.

**Intermediate Aquifer System:** The intermediate aquifer system (IAS) includes water-bearing and confining units between the SAS and the underlying Floridan Aquifer System.[5] The intermediate aquifer system consists of inter-bedded confining and aquifer units: an upper confining unit (UICU) consisting of a clayey and pebbly sand, clay and marl; an upper aquifer unit (PZ 2) consisting of a carbonate rocks, sand and discontinuous beds of sand and clay (mostly Arcadia Formation), an intermediate confining

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[4] Miller, J.A., 1986, *Hydrogeologic Framework Of The Floridan Aquifer System In Florida and Parts of Georgia, Alabama and South Carolina,* USGS Professional Paper No. 1403-B, 91 p.

[5] Duerr, A.D., Hunn, J.D., Lewelling, B.R., and Trommer, J.T., 1988, *Geohydrology and 1985 Water Withdraws of the Aquifer Systems in Southwest Florida, With Emphasis on the Intermediate Aquifer System*: U.S. Geological Survey Water Resources Investigations Report 87-4259, 115 p.



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unit (MICU), consisting of beds of sands and clays; a lower intermediate aquifer unit (PZ 3), consisting of carbonate rocks, minor sandy zones, clays, and local chert (Tampa Member).[6]

The confining units of the IAS retard the vertical movement of the ground water between the water producing zones of the IAS, and between the SAS and the underlying Floridan Aquifer.

Recharge to the IAS is by downward leakage from the SAS and more directly through sinkholes that breach the semi-confining layers. The ISA is a major source of water throughout much of Central Florida. Well yields from the IAS are greater than from the SAS; however, they are much less than from the wells penetrating the lower Florida Aquifer System.[7]

**IAS Site Vicinity:** In the site vicinity the thickness of the IAS is estimated from drilling records for the New Wales Chemical Plant Gypsum Stack Phase II Expansion and the Green Bay Chemical Plant Gypsum Stack Expansion and Regional Storage Pond DRI and FDEP construction permit applications to be on the order of 150 to 200 feet in thickness (G-5).[8]

The upper confining unit in the site vicinity has reported to be on the order of 110 feet thick and consists of an inter-bedded sequence of relatively low permeability clays and carbonates (G-5). The vertical hydraulic conductivities tests of intact core samples of the upper confining unit have been measured to range from $10^{-6}$ to $10^{-8}$ cm/sec (G-6).

The producing zone of the IAS in the site vicinity consists of approximately 80 feet of relatively permeable sandy limestone and sand deposits of the Tampa and Nocatee Members of the Arcadia Formation (G-5). The measured horizontal hydraulic conductivity in the site vicinity ranges from $10^{-5}$ to $10^{-6}$ cm/sec (G-6). The water level in the IAS producing zone varies from 40 feet to 90 feet (NGVD) depending on the season of the year (wet/dry).[9, 10]

The lower confining unit of the IAS in the vicinity of the site ranges in thickness from 10 to 15 feet and consists of relatively low permeability clay which occurs at the base of the Nocatee Member of the Arcadia Formation (G-5). The vertical hydraulic conductivity of the lower confining unit clay was measured at $10^{-7}$ to $10^{-9}$ cm/sec (G-6).[11]

The total thickness of the IAS in the site vicinity is on the order of 200 feet plus in thickness (G-5).

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6 Duerr, *Ibid.*

7 Barr, G.L., 1992, *Ground-Water Contamination Potential and Quality in Polk County, Florida*, U.S. Geological Survey, Water-Resources Investigations Report 92-4086, p 17, 92.p

8 New Wales Gypsum Stack Expansion ADA/DRI, Green Bay Gypsum Stack Expansion and Regional Storage Pond.

9 Ardaman & Associates, Inc., 2001, *Engineering Report in Support of FDEP Construction/Operation Permit Application, Phase II Gypsum Stack Expansion, New Wales Plant, IMC Phosphates Company*, p. 4-8

10 SWWMD GIS files, September 2001 and May 2001 ISA, shape files of USGS Intermediate Aquifer Potentiometric Surface May and September 2001.

11 Ardaman & Associates, Inc. 1988, Engineering Report for New Wales Gypsum Stack and Cooling Pond Expansion, Volume I, IMC-Fertilizer, Inc., New Wales Operations.



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**Floridan Aquifer System (FAS):** The Floridan Aquifer System (FAS) is a thick sequence of generally continuous carbonate rocks of Tertiary Age that are generally of high permeability, hydraulically connected to each other, and with a permeability (ability to supply water), which is of a much greater magnitude than the sediments / rocks above or below this zone.[12] The FAS is comprised of upper and lower aquifers that are separated by a middle-confining unit.[13]

The Upper FAS (UFAS) is the fresh water zone (except along the coastal areas and where it is mineralized to the south), while the middle confining unit and the Lower Floridan Aquifer generally contain saltwater.[14] In most reports, the Floridan aquifer is the term used to apply to only the upper water-bearing unit. The water bearing rocks of the UFAS are composed of carbonate units of the Suwannee and Ocala Limestones and the Avon Park Formation of Oligocene and Eocene age.

The Mid Florida Confining Unit (MFCU) is characterized by limestone which has reduced permeability due to the presence of inter-granular evaporates.[15] The MFCU consists of a thick, massive sequence of evaporite materials of very low permeability.[16]

The Lower Floridan Aquifer System (LFAS) consists of interbedded dolomite and anhydrite generally with low permeability. The connate water in the LFAS is saltwater brine.[17] The poor quality water, deep depth, low yields, and separation from the UFAS by the MFCU has resulted in the LFAS being used in Central Florida for the disposal of industrial waste through deep well injection.

The UFAS is the major water supply zone utilized as a water source by almost all major production wells for such interests as municipal, industrial, mining and agricultural except in Pinellas County where salt water intrusion from prior over pumping has caused salt water intrusion making it unusable as a source of water supply.

**UFAS Site Vicinity:** In the vicinity of the site the depth estimates to the top of the UFAS vary, ranging from approximately 250 feet below surface[18] to 275 feet below land surface.[19] Geotechnical

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[12] Ryder, P.D., 1985, Hydrology of the Floridan Aquifer System in West-Central Florida: U.S. Geological Survey Professional Paper 1403-F, 63 p.

[13] Miller, J.A., 1986, Hydrogeologic Framework of the Floridan Aquifer System in Florida and in Parts of Georgia, South Carolina, and Alabama: U.S. Geological Survey Professional Paper 1403-B, 91p.

[14] Ryder, P.D., 1985, Hydrology of the Floridan Aquifer System in West-Central Florida: U.S. Geological Survey Professional Paper 1403-F, 63 p.

[15] Southeastern Geological Society, 1986, *Hydrogeological Units of Florida*: Florida Geological Survey Special Publication 28, 9 p.

[16] Miller, *Ibid*, 1986.

[17] Miller, *Ibid*, 1986.

[18] Arthur, J. etal, 2008, Hydrogeologic *Framework of the Southwest Florida Water Management District*: Tallahassee, Florida, Geological Survey Bulletin No. 68.

[19] Ardaman & Associates, Inc., *Ibid*, 2001, p 4-5.



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investigations at the nearby New Wales Gypsum Stack Phase II Expansion reported that the depth to the top of the UFAS was 275 feet (G-5).[20] Recent documents by the USGS indicate that the depth to the UFAS is on the order of 250 to 300 feet in the vicinity of the site.[21] Using the thickness of the Intermediate Aquifer plus the thickness of the surfical aquifer/depth to top of the bed rock in the mining area a generalized depth to the top of the Floridan Aquifer has been generated from these sources (G-7).

The elevation of the potentiometric surface of the FAS in the vicinity of the site ranges from 50 to 70 feet elevation from the dry season to the wet season (G-9). The groundwater flow direction for both the IAS and the FAS is east to the west-southwest across the site (G-8, G-9, G-11 and G-12).

**Proximity to Wells**

The Polk County Utilities Department has several water supply wells to the east of the site in Bradley Junction and Rolling Hills (G-10). The Rolling Hills public supply well is approximately 4,200 feet east of the site and is up-gradient of the site. The Bradley Junction public supply well is located approximately 5,700 feet to the southeast of the site and is also located up-gradient of the site. In addition, there is an additional well located in Bradley Junction that is approximately 5,500 feet south of the site which is side-gradient to the site (G-10). Most of the down-gradient wells are sealing water wells from the prior mining operations (G-10).

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[20] Ardaman & Associates, Inc., *Ibid*, 2001, p 4-5.

[21] Spechler, R.M. and Kroening, S.E., 2007, *Hydrology of Polk County Florida*: U.S. Geological Survey Scientific Investigations Report 2006-5320, Figure 23, p. 29.



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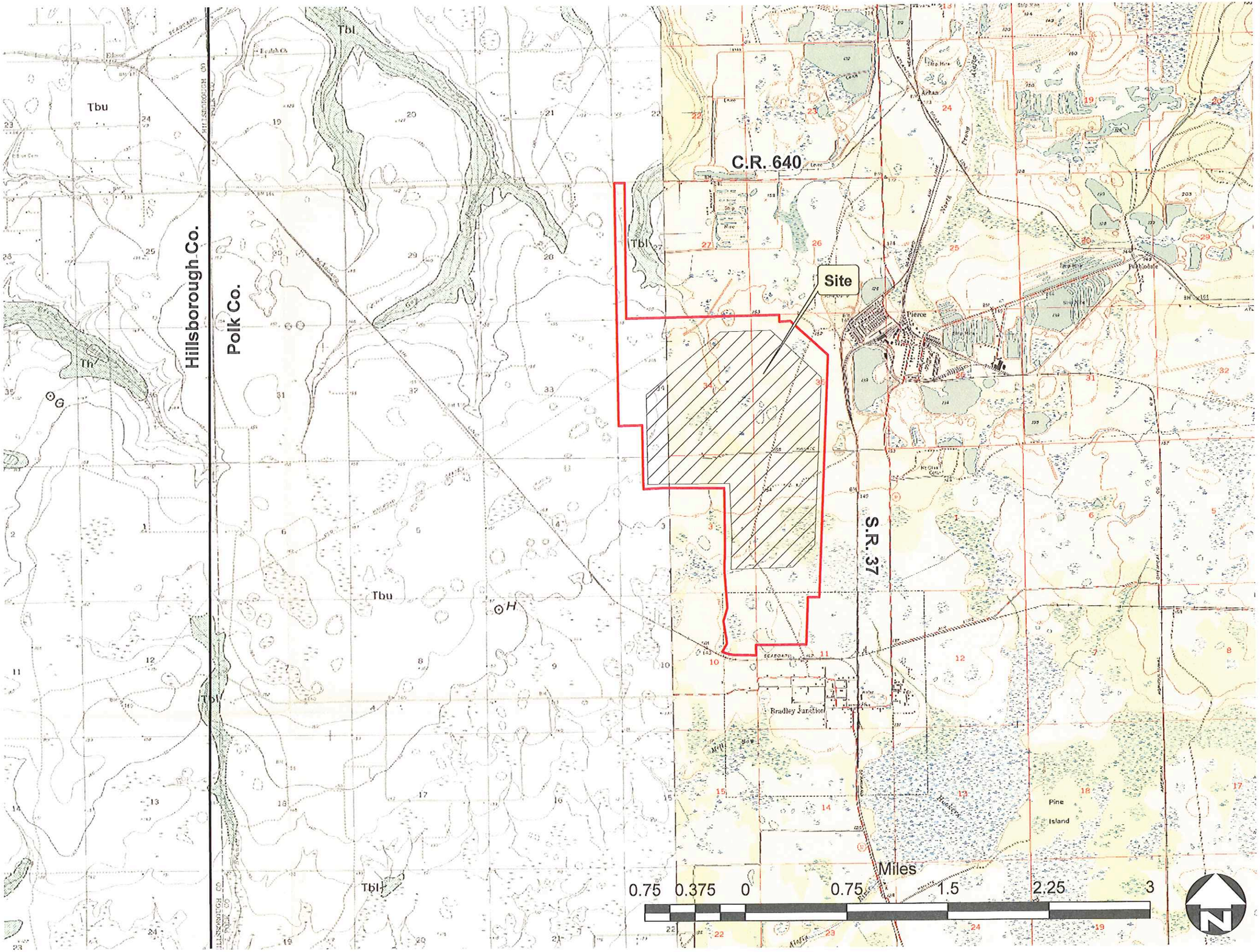
# GEOLOGY AND HYDROLOGY REPORT

# MAPS




## LEGEND

- Site Boundary
- Landfill Foot Print
- County Boundaries

**SOURCES:**

FGDL Polk Core
USGS Bradley Junction 1950 Quadrangle Map
USGS Mulberry 1950 Quadrangle Map
USGS, Geological Survey Bulletin 1128,
Cathcart, James B, Geologic Map of the
Keysville Quadrangle, Florida 1957.



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# INNOVATION ENVIRONMENTAL PARK

## HISTORICAL TOPOGRAPHY (Pre-mining)

| | | |
|---|---|---|
| SCALE: 1" = XXX' | DRAWN BY: TMG | DRAWING NO: G-1 |
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D:\ARCDATA\Innovation\EnvPark\G-1 Historical Topography

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| System | Series | Stratigraphic Unit | General Lithology | Major Lithologic Unit | Hydrogeologic Unit | |
|---|---|---|---|---|---|---|
| Quaternary | Holocene and Pleistocene | Surficial sand, terrace sand, phosphorite | Predominantly fine sand; interbedded clay, marl, shell, and phosphorite. | Sand | Surficial Aquifer | |
| Tertiary | | Caloosahatchee Formation | | | | |
| | Pliocene | Tamiami Formation | Clayey and pebbly sand; clay, marl, shell, phosphatic. | Clastic | Upper Confining Unit | Intermediate Aquifer System |
| | Miocene | Hawthorn Group: Bone Valley Member / Venice Clay; Peace River Formation | Dolomite, sand, clay, and limestone, silty, phosphatic. | Carbonate and Clastic | Middle Confining Unit | |
| | | Hawthorn Group: Arcadia Formation; Tampa Member / Nocatee Member | Limestone, sandy, phosphatic, fossiliferous; sand and clay in lower part in some areas. | | Lower Confining Unit | |
| | Oligocene | Suwannee Limestone | Limestone, sandy limestone, fossiliferous. | Carbonate | Upper Floridan Aquifer | Floridan Aquifer System |
| | Eocene | Ocala Limestone | Limestone, chalky, foraminiferal, dolomitic, near bottom. | | | |
| | | Avon Park Formation | Limestone and hard brown dolomite; intergranular evaporite in lower part in some areas. | Carbonate with Evaporites | Middle Confining Unit | |
| | | Oldsmar and Cedar Keys Formations | Dolomite and limestone with intergranular gypsum and anhydrite. | | Lower Floridan Aquifer | |
| | Paleocene | | | Evaporites | Sub-Floridan Confining Unit | |



SOURCES:

SWFWMD Aquifer Characteristics within the Southwest Florida Water Management District, Report 99-1, February 2000.

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**INNOVATION ENVIRONMENTAL PARK**

**HYDROGEOLOGIC FRAMEWORK**

| SCALE: 1" = XXX' | DRAWN BY: TMG | DRAWING NO: G-2 |
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D:\ARCDATA\InnovationEnvPark\G-2 Hydrologic Framwork

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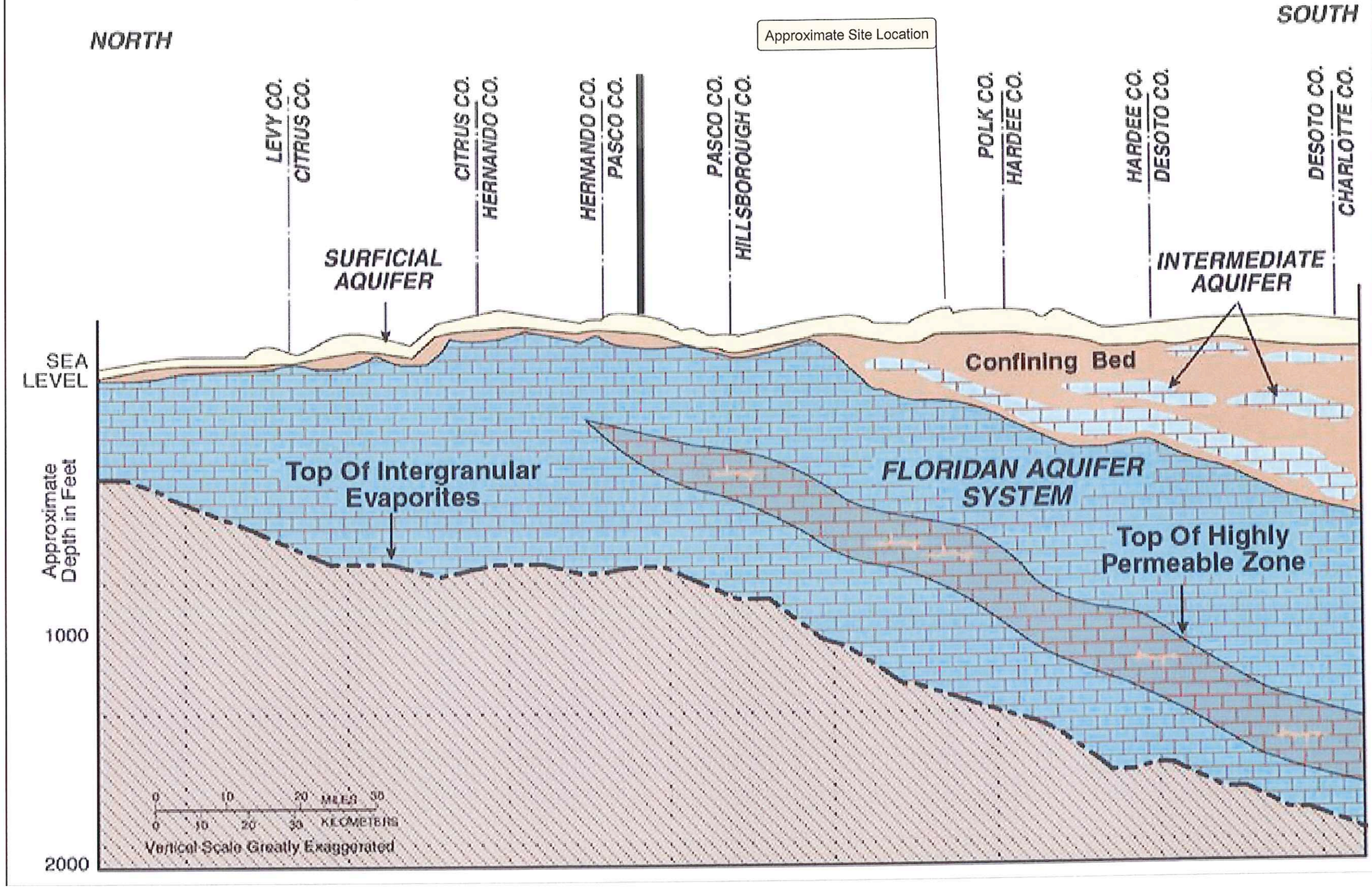
# General Hydrogeologic Cross Section of the Region




SOURCES:

SWFWMD

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**REGIONAL HYDROGEOLOCIC CROSS-SECTION**

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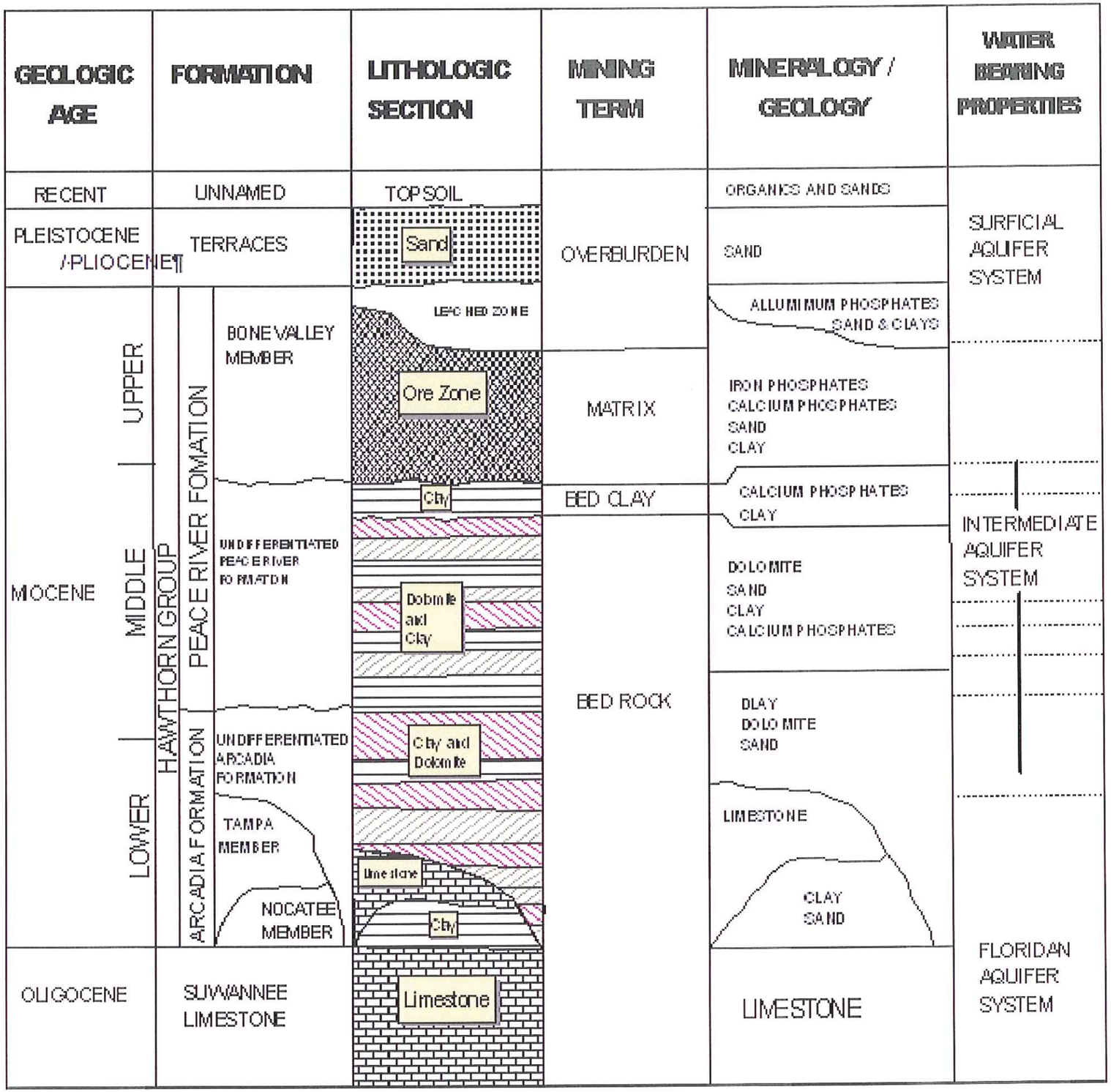


Source: Yon, 1983; Scott, 1986; Campbell, 1988

SOURCES:
Ona Mine DRI Figure 14-1

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**HYDROGEOLOGIC FRAMEWORK OF PHOSPHATE DISTRICT**

| | | |
|---|---|---|
| SCALE: 1" = XXX' | DRAWN BY: TMG | DRAWING NO: G-4 |
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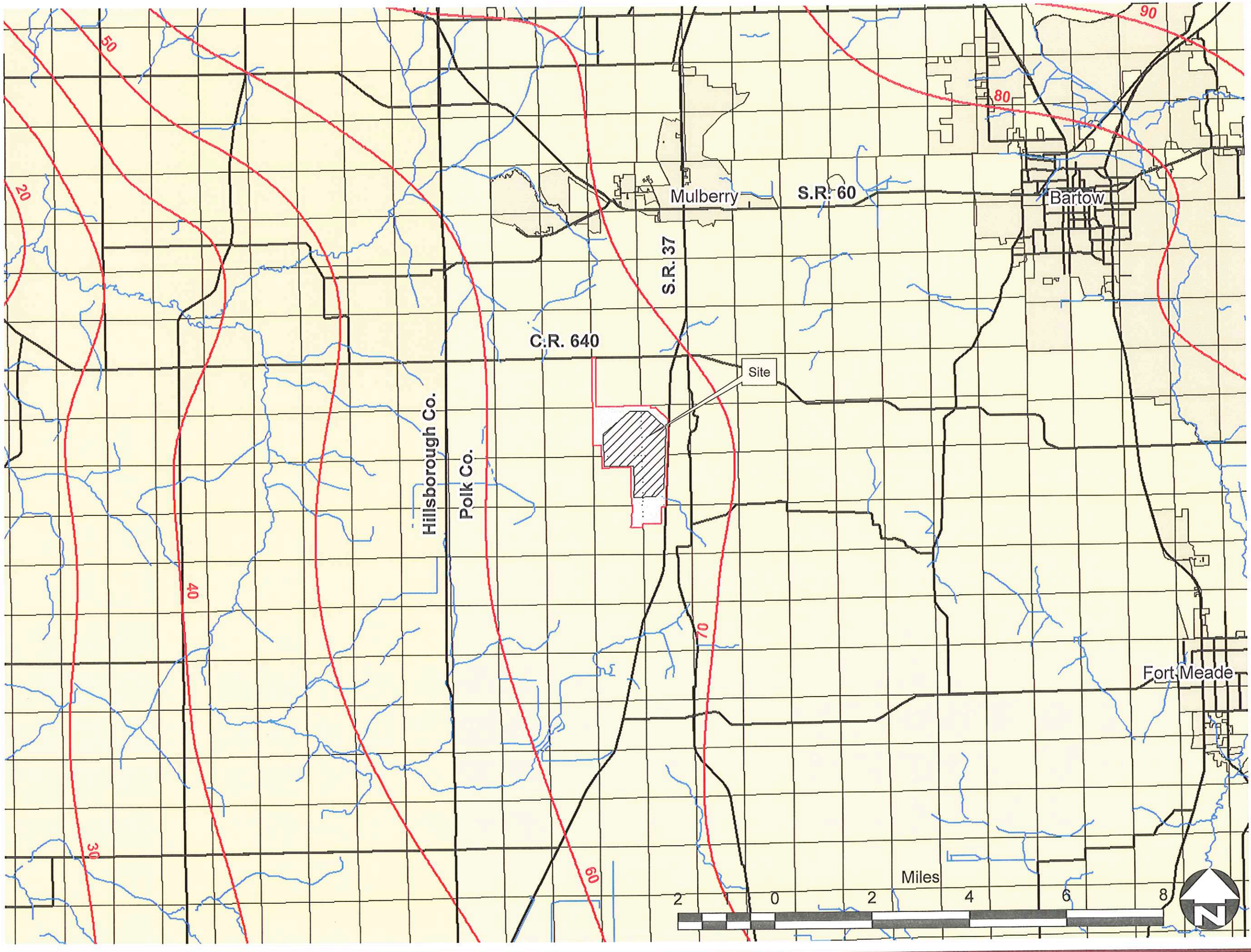


## LEGEND

- Landfill Foot Print
- Site Boundary
- County Boundaries
- FL Aquifer Sept 2008 Elev
- Streams
- Roads
- Sections
- Municipalities

**SOURCES:**
SWFWMD GIS POT MAPS
FGDL Polk Core, Hillsborough Core



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# INNOVATION ENVIRONMENTAL PARK

## FLORIDAN AQUIFER POTENTIOMETRIC ELEVATION SEPTEMBER 2008

| | | |
|---|---|---|
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D:\ARCDATA\InnovationEnvParkIG-08_FLAQPot Sept 2008

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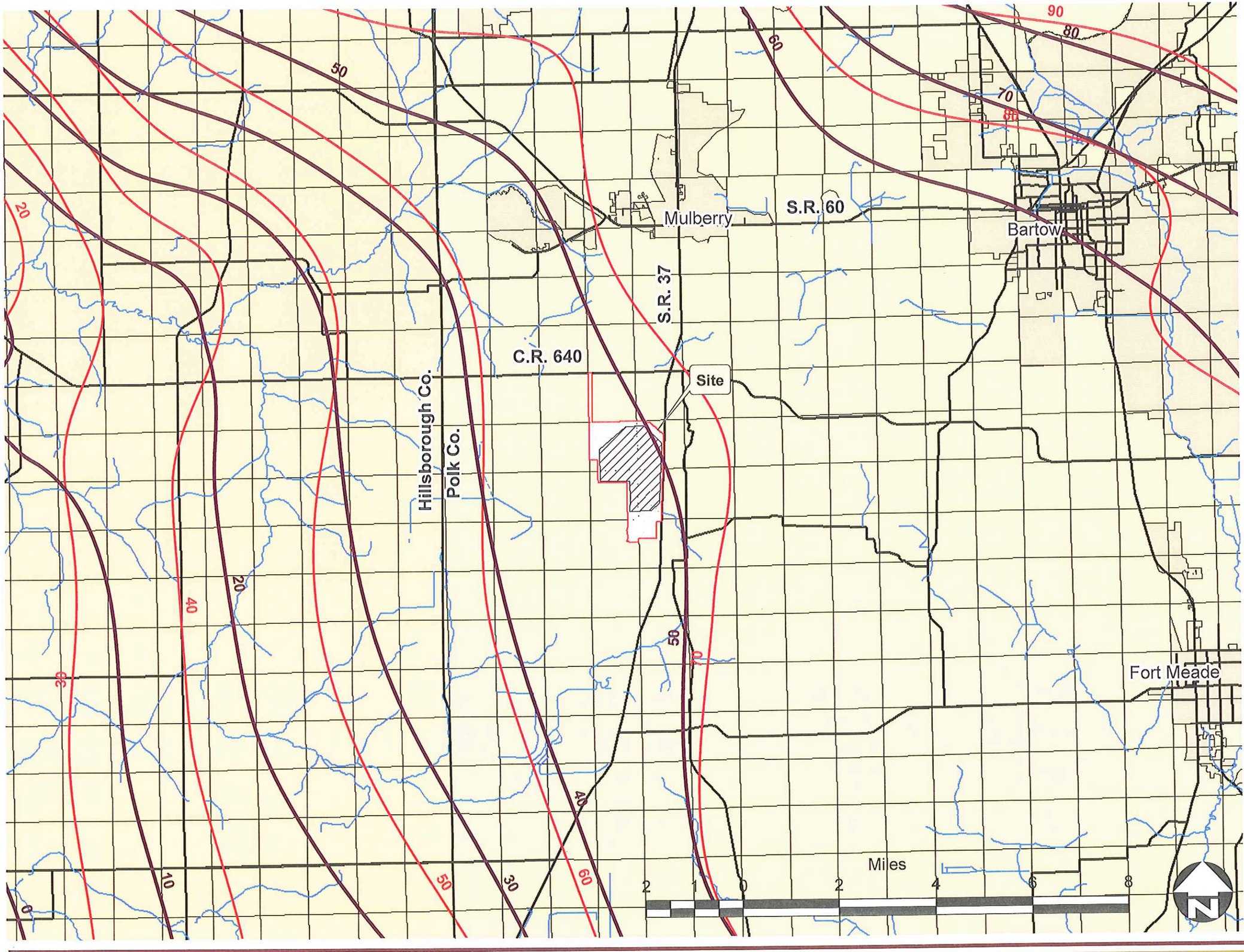


## LEGEND

- Site Boundary
- Landfill Foot Print
- FL Aquifer May 2008 Elev
- FL Aquifer Sept 2008 Elev
- Streams
- Roads
- Sections
- Municipalities
- County Boundaries

**SOURCES:**
SWFWMD - BASE AERAL (2008)
POLK COUNTY PROPERTY APPRAISER - PARCELS (08/17/09)

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## FLORIDAN AQUIFER POTENTIOMETRIC ELEVATION SEPTEMBER vs MAY 2008

| | | |
|---|---|---|
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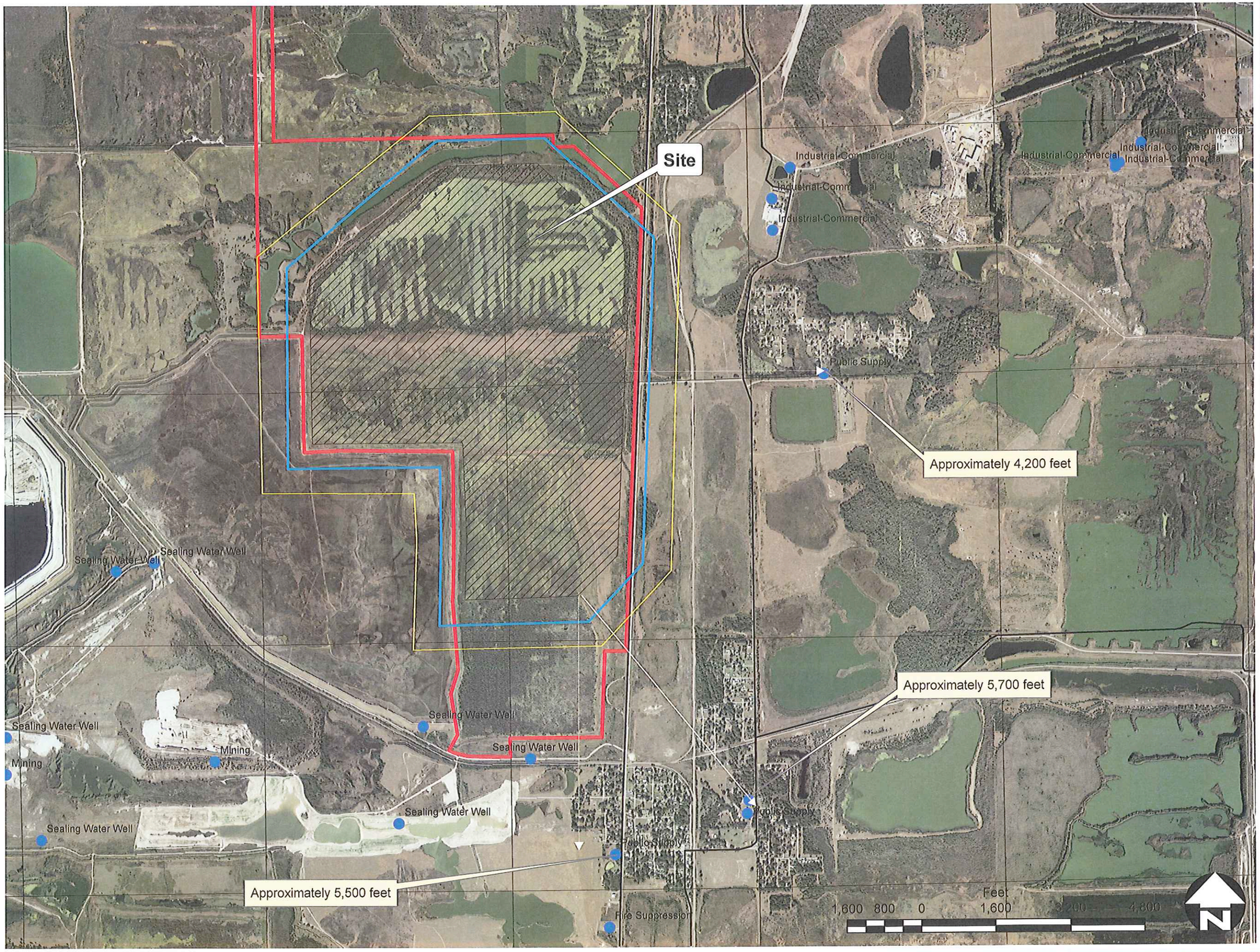


## LEGEND

- Site Boundary
- Landfill Foot Print
- Landfill_FP+500 Feet
- Landfill_FP+1000 Feet
- WUP Wells
- Roads
- Sections

**SOURCES:**

SWFWMD GIS, Aerial Photograph 2008
FDGL Polk Core

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## INNOVATION ENVIRONMENTAL PARK

## WELLS IN VICINITY OF SITE

| | | |
|---|---|---|
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