mcgehee engineering corp

July 10, 2015

Mr.Stephen Miles, P.E.
**Alabama Surface Mining Commission**
P. O. Box 2390
Jasper, AL 35502-2390

RE: **Oak Grove Resources, LLC**
Concord Preparation Plant, P-3233

Dear Mr. Miles:

I hereby certify the enclosed detailed design plans for Sediment Basin 050 for the above referenced mine are in accordance with the Regulations of the Alabama Surface Mining Commission as adopted by Act 81-435 of December 18, 1981 and as amended to date and that the information used in the enclosed basin design plans is true and correct to the best of my knowledge and belief.

If you have any questions or need additional information, please do not hesitate to contact our office.

Sincerely,

**McGehee Engineering Corp.**

ALABAMA LICENSED PROFESSIONAL No. 15917 ENGINEER ROBERT W. USHER

Robert W. Usher, P.E.
Alabama Reg. No. 15917

Post Office Box 3431 • 450 19th Street West • Jasper, Alabama 35502-3431 • 205-221-0686 • Fax 205-221-7721 • staff@mcgehee.org

## INTRODUCTION

Sediment Basin 050 is proposed to control runoff from areas currently used and additional areas to be added as coarse refuse disposal facilities. Diversion 1 will be constructed to route runoff from these disturbed areas once the sediment basin is constructed.

To provide adequate sediment and detention storage excavation within the pool area will be conducted. The majority of the material will be used in the construction of the embankment.

There are two (2) 42 inch corrugated metal pipes installed within the railroad spur line that route runoff north of the railroad to the basin. The flood routing of the watersheds addressed these structures.

## SEDIMENT BASIN CONSTRUCTION SPECIFICATIONS

Sediment basins (temporary or permanent) will be designed and constructed using the following as minimum specifications:

### 1. EMBANKMENT REQUIREMENTS

A) The minimum width of the top of the embankment will under no circumstance be less than twelve (12) feet.

B) The embankment will have a minimum front and back slope no steeper than the slopes listed on the detailed design sheet.

C) The foundation area of the embankment will be cleared and grubbed of all organic matter with no surface slope steeper than 1 horizontal to 1 vertical. The entire wet area, as measured from the upstream toe of the embankment to the normal pool level, will be cleared of trees and large brush.

D) A core will be constructed in a cutoff trench along the centerline of the embankment. The cutoff trench will be of suitable depth and width to attain relatively impervious material.

E) The embankment construction material will be free of sod, roots, stumps, rocks, etc., which exceed six (6") inches in diameter. The embankment material will be placed in layers of twelve (12") inches or less and compacted to ninety five (95%) percent of the standard proctor density, as set forth in ASTM.

F) The embankment, foundation and abutments will be designed and constructed to be stable under normal construction and operating conditions, with a minimum static safety factor of 1.3 at normal pool level with steady seepage saturation conditions.

G) The actual constructed height of the embankment will be a minimum of five (5%) percent higher than the design height to allow for settling over the life of the embankment.

H) The design embankment height for temporary impoundments will be a minimum of one (1) foot above the maximum water level anticipated from a 10 Year - 24 Hour or a 25 Year - 6 Hour precipitation event (whichever is greater). The design embankment height for permanent impoundments will be a minimum of one (1) foot above the maximum water level anticipated from a 10 Year - 24 Hour or a 25 Year - 6 Hour precipitation event (whichever is greater).

I) For embankments constructed as point source discharges, the embankment will be constructed and abutments keyed into undisturbed, virgin, ground if at all possible. In the event that this can not be achieved, additional design and construction specifications will be submitted in the detailed design plans.

J) The embankment and all areas disturbed in the construction of the embankment will be seeded with a mixture of perennial and annual grasses, fertilized and mulched to prevent erosion and ensure restabilization. Hay dams, silt fences, rock check dams, etc. will be installed, where deemed necessary, as additional erosion prevention methods.

## 2. DISCHARGE STRUCTURE REQUIREMENTS

A) The primary spillway will be designed to adequately carry the anticipated peak runoff from a 10 Year - 24 Hour precipitation event. The combination primary and secondary (emergency) spillway system will be designed to safely carry the anticipated peak runoff from a 25 Year - 6 Hour precipitation event. When sediment basins are proposed in the drainage course of a public water supply, the spillway system will be designed and constructed to adequately carry the runoff from a 50 Year - 24 Hour precipitation event.

B) Channel linings, for secondary (emergency) spillways will be a trapezoidal open channel constructed in natural ground and planted with a mixture of both annual and perennial grasses being predominantly fescue and bermuda. In the event that the spillway can not be constructed in natural ground the spillway will be lined with riprap, concrete, asphalt or durable rock (See Detailed Design Plans for Spillway Lining).

C) When consisting of pipe, the primary spillway will be installed according to Class "C" pipe installation for embankment bedding.

D) Sediment basins with a single spillway system, such as a skimmer board, will be a trapezoidal open channel constructed in consolidated, nonerodible material and lined with rip-rap, concrete, asphalt or durable rock (See Detailed Design Plans for Spillway Lining).

E) The primary spillway will be designed and constructed with device to eliminate floating solids from leaving the impoundment. This device will consist of a turned down elbow when using pipe or a skimmer system when using an open channel spillway.

F) When necessary, to prevent erosion of the embankment or discharge area, a splash pad of rip-rap, durable rock, sacrete, etc. will be installed at the discharge end of the primary spillway.

G) The combined spillway systems, for sediment basins constructed in series, will be designed to adequately accommodate the entire drainage area.

## 3. INSPECTION, MAINTENANCE AND CERTIFICATION REQUIREMENTS

A) Inspections will be conducted regularly during construction of the sediment basin by a qualified registered professional engineer or other qualified person under the direction of a professional engineer. Upon completion of construction, the sediment basin will be certified, by a qualified registered professional engineer, to the Regulatory Authority as having been constructed in accordance with the approved detailed design plans.

B) Sediment basins will be inspected semi-monthly for erosion, instability, etc., with maintenance performed as necessary, until the removal of the structure or until a Phase III Bond Release is granted.

C) Sediment basins will be examined quarterly for structural weakness, instability, erosion, slope failure, or other hazardous conditions with maintenance performed as necessary.

D) Formal inspections will be made annually, by a qualified registered professional engineer or other qualified person under the direction of a professional engineer, including any reports or modifications, in accordance with 880-X- 10C- .20[1(j)] of the Alabama Surface Mining Regulations.

E) Retained sediment will be removed from each sediment basin when the accumulated sediment reaches the maximum allowable sediment volume as set forth in the detailed design plans.

## 4. BASIN REMOVAL REQUIREMENTS

A) Upon completion of mining, reclamation, restabilization and effluent standards being met, each sediment basin not proposed as a permanent water impoundment will be dewatered in a controlled manner by either pumping or siphoning. Upon successful dewatering, a determination will be made as to the retained sediment level in the basin. After determining the retained sediment level, a channel will be cut into the embankment down to the retained sediment level on the side of the embankment deemed most suitable to reach natural ground without encountering prohibiting rock. The embankment material removed from this newly constructed channel will be spread and compacted over the previous impoundment (wet area) area to prevent erosion and ensure restabilization. The newly constructed channel will be of adequate width (minimum 30 feet) and sloped to a grade (approximately 1% to 3%) which will cause all surface drainage to travel across this area in sheet flow, minimizing the possibility of erosion. Also, where necessary, hay dams will be installed in strategic locations across the width of the channel to retain sediment and slow the water velocity to a favorable rate. Upon removal of the

embankment section, all disturbed areas will be graded in such a manner to ensure slope stability, successful restabilization and to minimize erosion. All disturbed areas will be seeded with a mixture of annual and perennial grasses, fertilized and mulched. No slope, existing or created in the removal of the sediment basin, will be left on a grade that will slip or slough.

## 5. PERMANENT WATER IMPOUNDMENT REQUIREMENTS

A) Prior to a request for a Phase II Bond Release, all sediment basins being left as permanent water impoundments will have supplemental data submitted to the Regulatory Authority concerning water quality, water quantity, size, depth, configuration, postmining land use, etc.

B) Final grading slopes of the entire permanent water impoundment area will not exceed a slope of 2 Horizontal to 1 Vertical to provide for safety and access for future water users.

# DETAILED DESIGN PLANS
# SEDIMENT BASIN 050

# CONCORD BASIN 050 EXISTING

## Elevation-Area-Capacity Table

| Elevation (ft) | Area (ac) | Capacity (ac-ft) |
|---|---|---|
| 512.00 | 0.000 | 0.000 |
| 512.50 | 0.002 | 0.000 |
| 513.00 | 0.010 | 0.003 |
| 513.50 | 0.022 | 0.011 |
| 514.00 | 0.040 | 0.027 |
| 514.50 | 0.049 | 0.049 |
| 515.00 | 0.058 | 0.076 |
| 515.50 | 0.069 | 0.107 |
| 516.00 | 0.080 | 0.144 |
| 516.50 | 0.093 | 0.188 |
| 517.00 | 0.108 | 0.238 |
| 517.50 | 0.123 | 0.296 |
| 518.00 | 0.140 | 0.362 |
| 518.50 | 0.160 | 0.437 |
| 519.00 | 0.182 | 0.522 |
| 519.50 | 0.205 | 0.619 |
| 520.00 | 0.230 | 0.728 |
| 520.50 | 0.253 | 0.849 |
| 521.00 | 0.278 | 0.981 |
| 521.50 | 0.303 | 1.127 |
| 522.00 | 0.330 | 1.285 |
| 522.50 | 0.358 | 1.457 |
| 523.00 | 0.388 | 1.643 |
| 523.50 | 0.418 | 1.845 |
| 524.00 | 0.450 | 2.062 |
| 524.50 | 0.492 | 2.297 |
| 525.00 | 0.536 | 2.554 |
| 525.50 | 0.582 | 2.834 |
| 526.00 | 0.630 | 3.137 |
| 526.50 | 0.677 | 3.464 |
| 527.00 | 0.727 | 3.814 |
| 527.50 | 0.777 | 4.190 |
| 528.00 | 0.830 | 4.592 |
| 528.50 | 0.898 | 5.024 |
| 529.00 | 0.970 | 5.491 |
| 529.50 | 1.043 | 5.994 |
| 530.00 | 1.120 | 6.535 |

| Elevation (ft) | Area (ac) | Capacity (ac-ft) |
|---|---|---|
| 530.50 | 1.254 | 7.128 |
| 531.00 | 1.395 | 7.790 |
| 531.50 | 1.544 | 8.524 |
| 532.00 | 1.700 | 9.335 |
| 532.50 | 1.892 | 10.232 |
| 533.00 | 2.094 | 11.229 |
| 533.50 | 2.307 | 12.329 |
| 534.00 | 2.530 | 13.537 |
| 534.50 | 2.780 | 14.864 |
| 535.00 | 3.041 | 16.319 |
| 535.50 | 3.315 | 17.908 |
| 536.00 | 3.600 | 19.636 |

# CONCORD BASIN 050 EXCAVATED

## Elevation-Area-Capacity Table

| Elevation (ft) | Area (ac) | Capacity (ac-ft) |
|---|---|---|
| 512.00 | 0.030 | 0.000 |
| 512.50 | 0.040 | 0.017 |
| 513.00 | 0.052 | 0.040 |
| 513.50 | 0.065 | 0.070 |
| 514.00 | 0.080 | 0.106 |
| 514.50 | 0.093 | 0.149 |
| 515.00 | 0.108 | 0.200 |
| 515.50 | 0.123 | 0.257 |
| 516.00 | 0.140 | 0.323 |
| 516.50 | 0.158 | 0.398 |
| 517.00 | 0.178 | 0.482 |
| 517.50 | 0.198 | 0.576 |
| 518.00 | 0.220 | 0.680 |
| 518.50 | 0.243 | 0.796 |
| 519.00 | 0.268 | 0.924 |
| 519.50 | 0.293 | 1.064 |
| 520.00 | 0.320 | 1.217 |
| 520.50 | 0.348 | 1.384 |
| 521.00 | 0.378 | 1.566 |
| 521.50 | 0.408 | 1.762 |
| 522.00 | 0.440 | 1.974 |
| 522.50 | 0.480 | 2.204 |
| 523.00 | 0.522 | 2.454 |
| 523.50 | 0.565 | 2.726 |
| 524.00 | 0.610 | 3.019 |
| 524.50 | 0.660 | 3.337 |
| 525.00 | 0.711 | 3.679 |
| 525.50 | 0.765 | 4.048 |
| 526.00 | 0.820 | 4.444 |
| 526.50 | 0.886 | 4.871 |
| 527.00 | 0.955 | 5.331 |
| 527.50 | 1.026 | 5.826 |
| 528.00 | 1.100 | 6.357 |
| 528.50 | 1.234 | 6.940 |
| 529.00 | 1.375 | 7.592 |
| 529.50 | 1.524 | 8.316 |
| 530.00 | 1.680 | 9.117 |

| Elevation (ft) | Area (ac) | Capacity (ac-ft) |
|---|---|---|
| 530.50 | 1.870 | 10.004 |
| 531.00 | 2.070 | 10.988 |
| 531.50 | 2.280 | 12.075 |
| 532.00 | 2.500 | 13.270 |
| 532.50 | 2.621 | 14.550 |
| 533.00 | 2.744 | 15.891 |
| 533.50 | 2.871 | 17.295 |
| 534.00 | 3.000 | 18.762 |
| 534.50 | 3.131 | 20.295 |
| 535.00 | 3.264 | 21.894 |
| 535.50 | 3.401 | 23.560 |
| 536.00 | 3.540 | 25.295 |

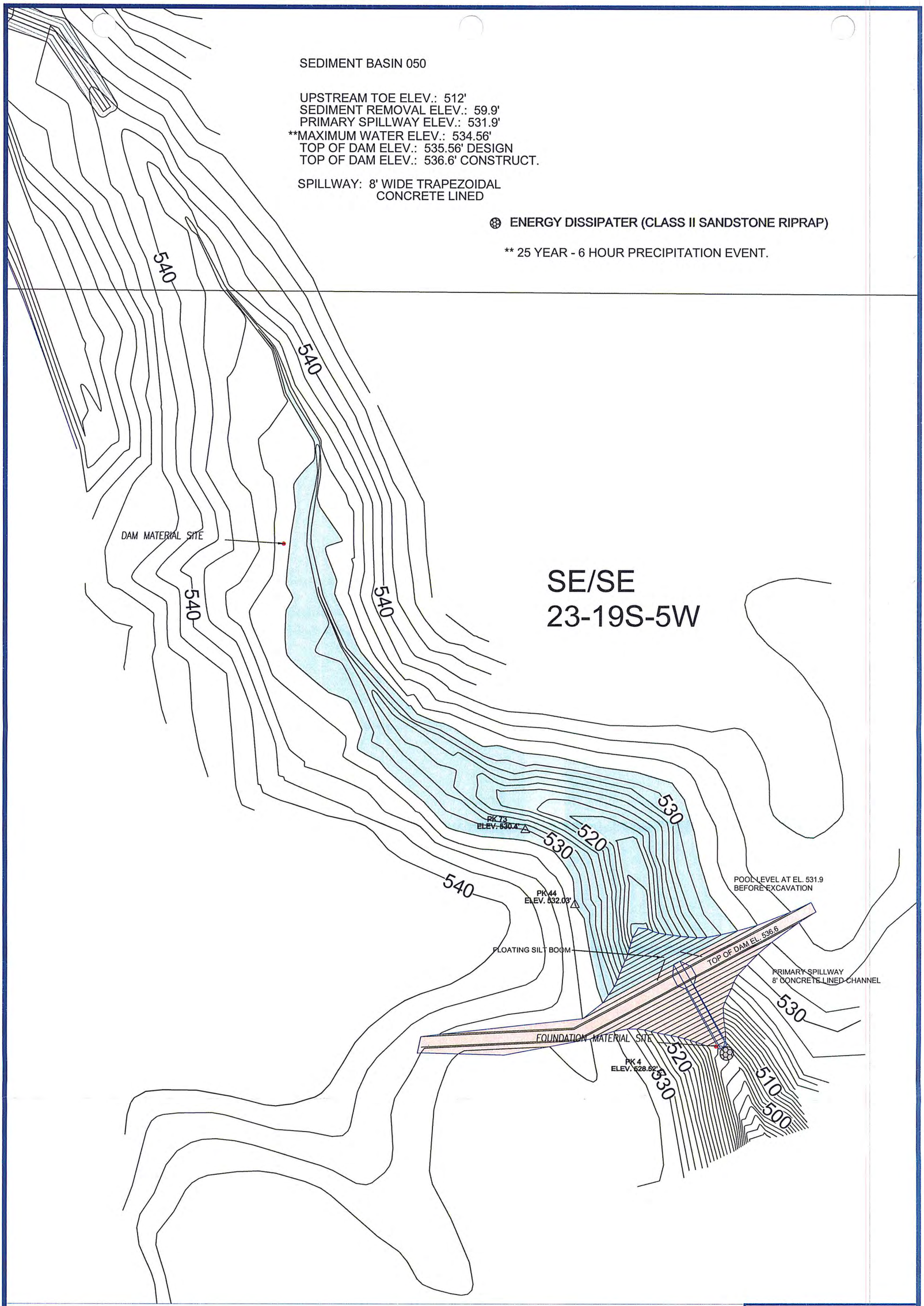
SEDIMENT BASIN 050

UPSTREAM TOE ELEV.: 512'
SEDIMENT REMOVAL ELEV.: 59.9'
PRIMARY SPILLWAY ELEV.: 531.9'
**MAXIMUM WATER ELEV.: 534.56'
TOP OF DAM ELEV.: 535.56' DESIGN
TOP OF DAM ELEV.: 536.6' CONSTRUCT.

SPILLWAY: 8' WIDE TRAPEZOIDAL
CONCRETE LINED

⊛ ENERGY DISSIPATER (CLASS II SANDSTONE RIPRAP)

** 25 YEAR - 6 HOUR PRECIPITATION EVENT.




EMBANKMENT

POOL AREA BEFORE EXCAVATION

2 FOOT CONTOUR INTERVAL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Bobby Usher-Z:\Mining\BASEMAPS\Cleveland Cliffs\Concord\BASIN DESIGN\POND 050 PLAN VIEW.dwg – Jul 10, 2015 – 9:18am

CLIFFS

CONCORD PREP PLANT
REFUSE PILE

SEDIMENT BASIN 050
PLAN VIEW BEFORE EXCAVATION

| FILE: | SCALE: 1"=100' | JOB NO.: |
|---|---|---|
| APPROVED BY: R.W.U. | DATE: 7/09/15 | SHEET NO.: 1 OF 1 |

SEDIMENT BASIN 050

UPSTREAM TOE ELEV.: 512'
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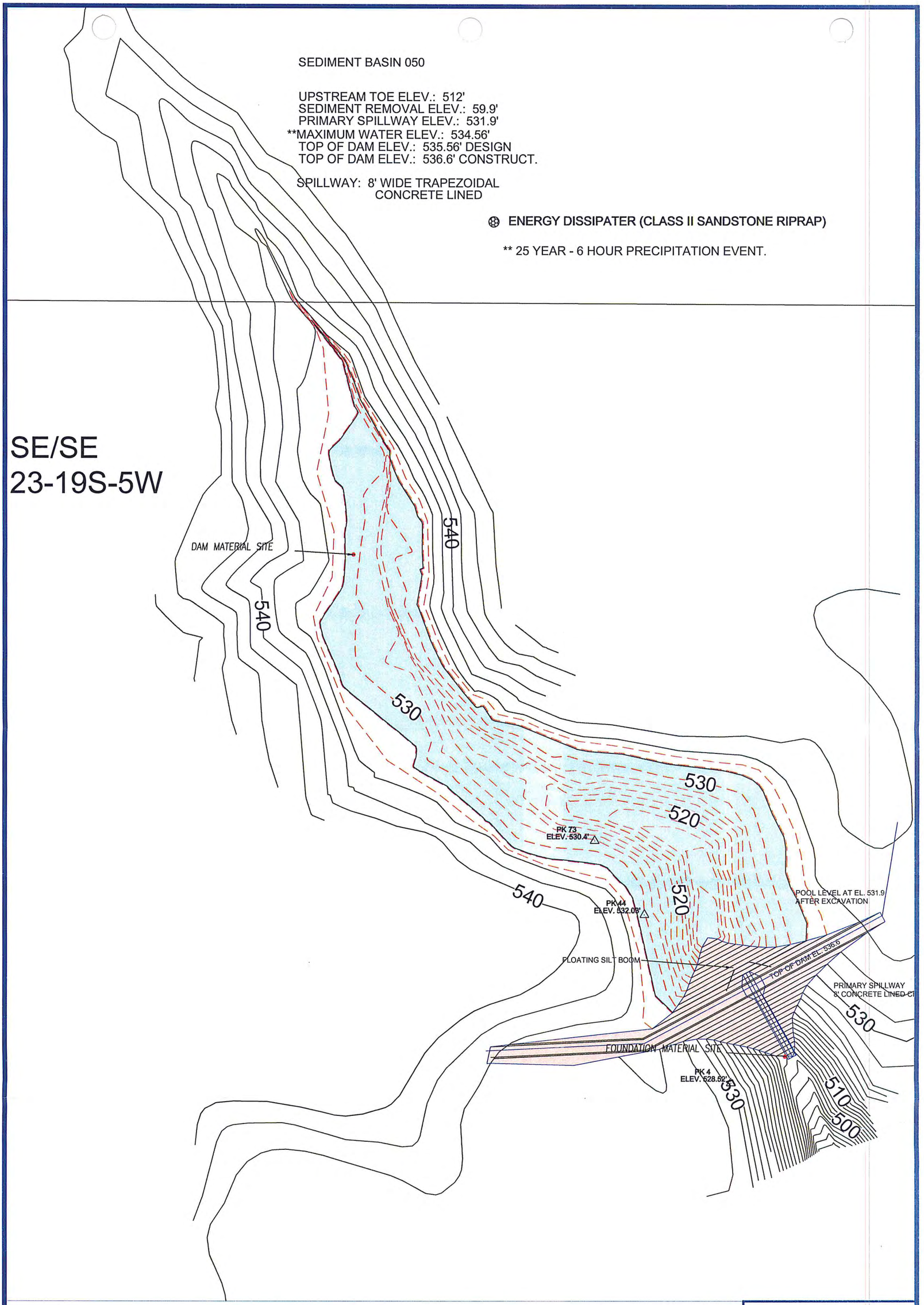
CONCRETE LINED

⊛ ENERGY DISSIPATER (CLASS II SANDSTONE RIPRAP)

** 25 YEAR - 6 HOUR PRECIPITATION EVENT.

SE/SE
23-19S-5W




EMBANKMENT

POOL AREA BEFORE EXCAVATION

EXCAVATED CONTOURS

2 FOOT CONTOUR INTERVAL

N
W E
S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CLIFFS

CONCORD PREP PLANT
REFUSE PILE

SEDIMENT BASIN 050
PLAN VIEW AFTER EXCAVATION

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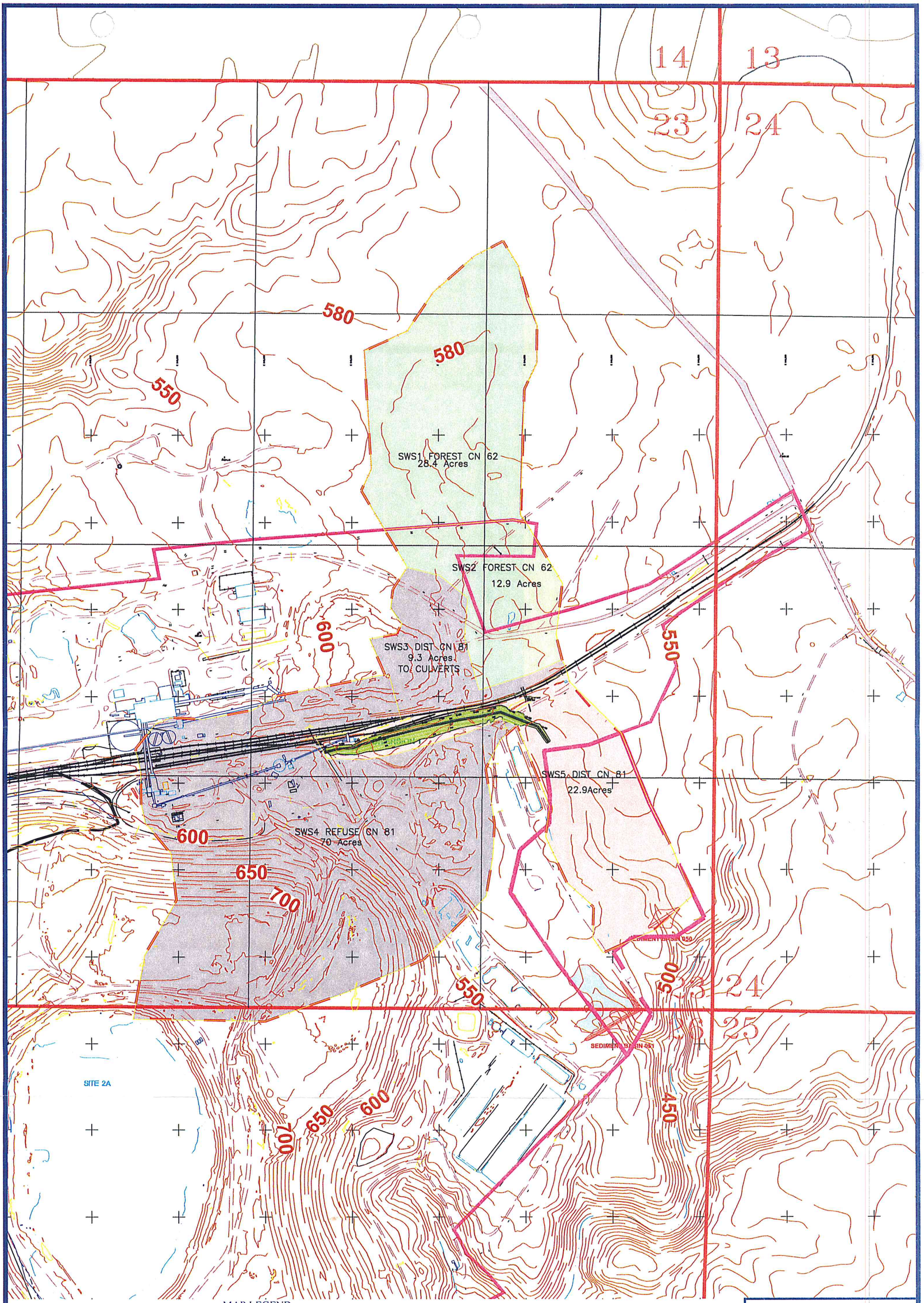
| APPROVED BY: R.W.U. | DATE: 7/09/15 | SHEET NO.: 1 OF 1 |




MAP LEGEND

ASMC PERMIT BOUNDARY

WATERSHED BOUNDARY

SWS1 & 2 FOREST CN 62

SWS3 COAL PILES & COARSE REFUSE CN 81

SWS4 COARSE REFUSE CN 81

SWS5 NATURAL GROUND CN 81

B SEDIMENT BASIN, C.N. 100

10 FOOT CONTOUR INTERVAL

N
W E
S

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Bobby Usher- Z:\Mine\BASEMAPS\Cleveland Cliffs\Concord\Proposed expansion\REVISED EXPANSION FILES ADDING 3A 4-16-15\REVISED Concord Refuse expansion SITE 3A ONLY 4-14-15.dwg – Jul 09, 2015 – 4:26pm

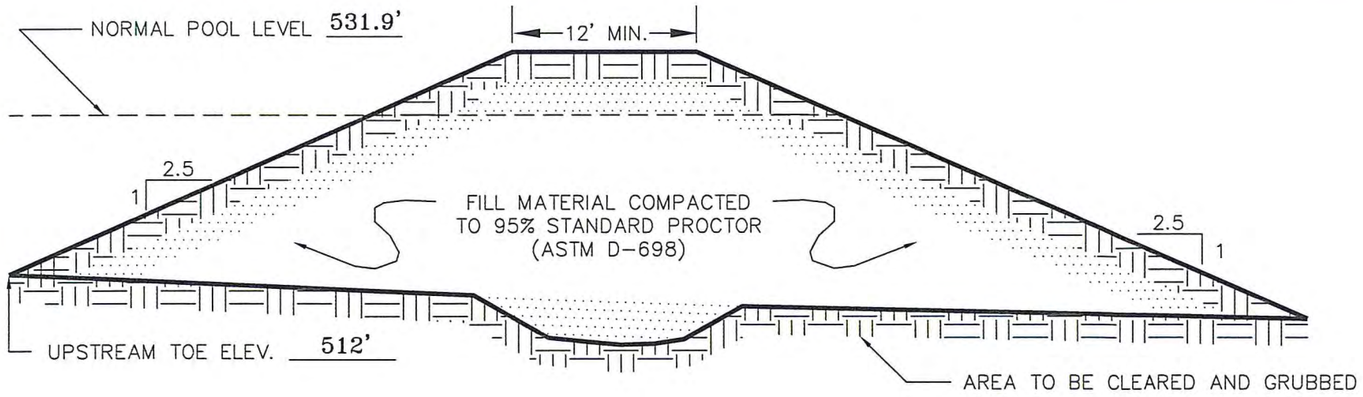
CLIFFS

CONCORD PREP PLANT
REFUSE PILE

SEDIMENT BASIN 050
WATERSHED MAP

| FILE: | SCALE: 1"=500' | JOB NO.: |
|---|---|---|
| APPROVED BY: R.W.U. | DATE: 7/9/15 | SHEET NO.: 1 OF 1 |

# EMBANKMENT CROSS-SECTION



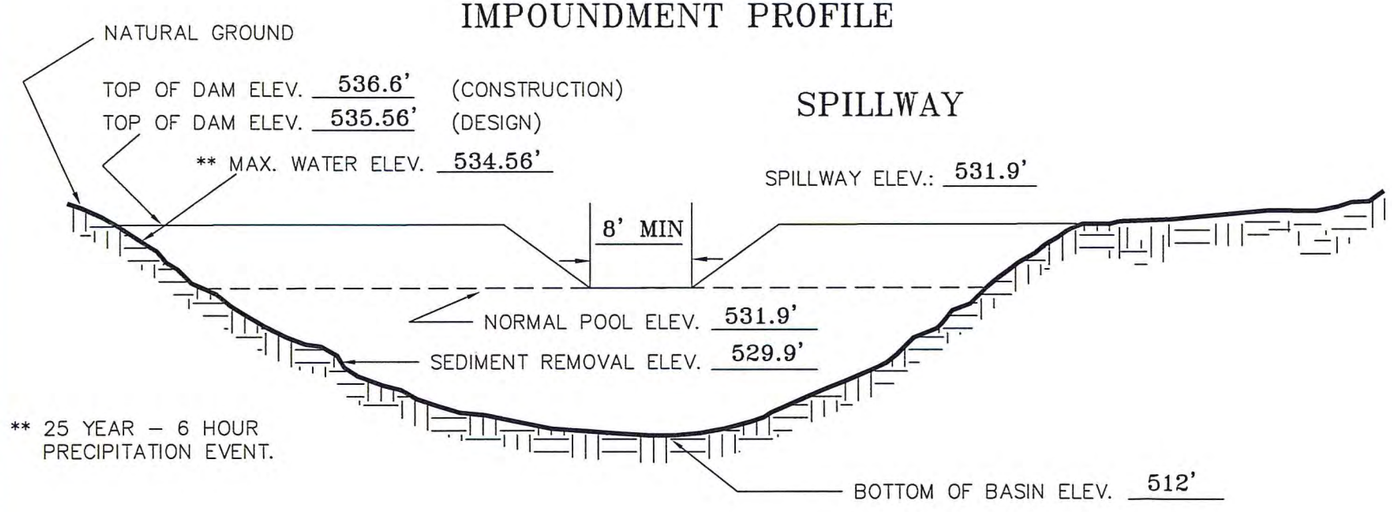

COMPANY: OAK GROVE RESOURCES, LLC

MINE NAME: CONCORD PREPARATION PLANT

PERMIT #: P-3233

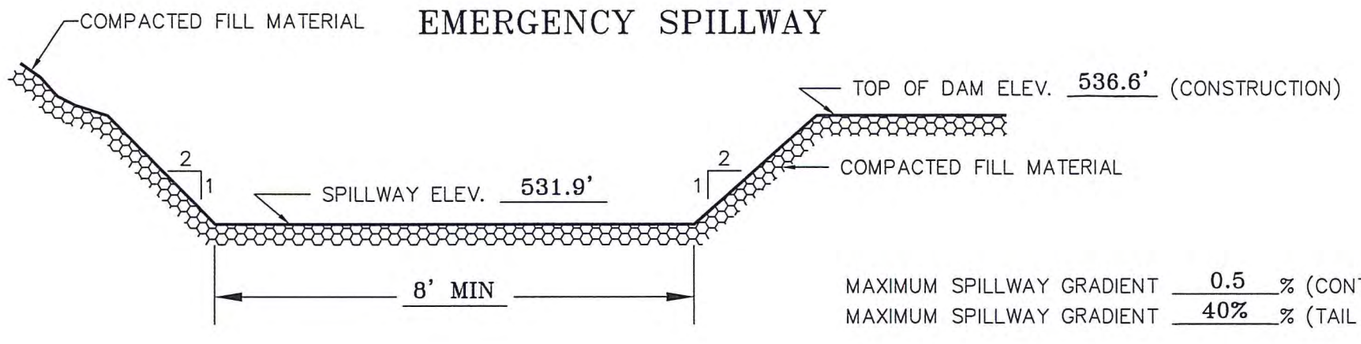
BASIN I.D. #: SEDIMENT BASIN 050

# IMPOUNDMENT PROFILE




## SPILLWAY

## EMERGENCY SPILLWAY




MAXIMUM SPILLWAY GRADIENT 0.5 % (CONTROL SECTION)

MAXIMUM SPILLWAY GRADIENT 40% % (TAIL DITCH SECTION)

SEE SPILLWAY CONTROL SECTION AND TAIL DITCH DESIGN FOR CHANNEL LINING REQUIREMENTS.

# KEY BASIN PARAMETERS

| | | |
|---|---|---|
| DRAINAGE AREA | 143.5 | ACRES |
| DISTURBED AREA | 102.2 | ACRES |
| SEDIMENT STORAGE | 9 | AC.FT. |
| DETENTION STORAGE | 4.3 | AC.FT. |
| PERMANENT POOL CAPACITY | 13.3 | AC.FT. |
| * TOTAL BASIN STORAGE CAPACITY | 19.54 | AC.FT. |
| ** PEAK INFLOW | 245.98 | C.F.S. |
| ** PEAK OUTFLOW | 136.61 | C.F.S. |

NOTE: ALL ELEVATIONS ASSUMED.

* 10 YEAR - 24 HOUR PRECIPITATION EVENT.

** 25 YEAR - 6 HOUR PRECIPITATION EVENT.

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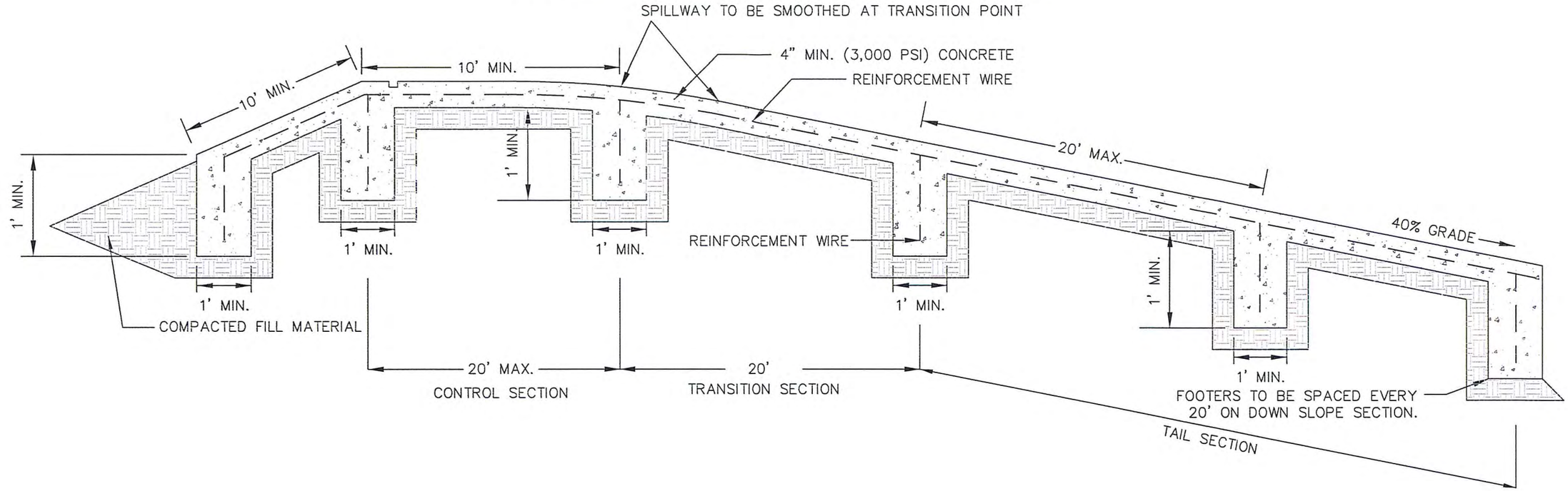
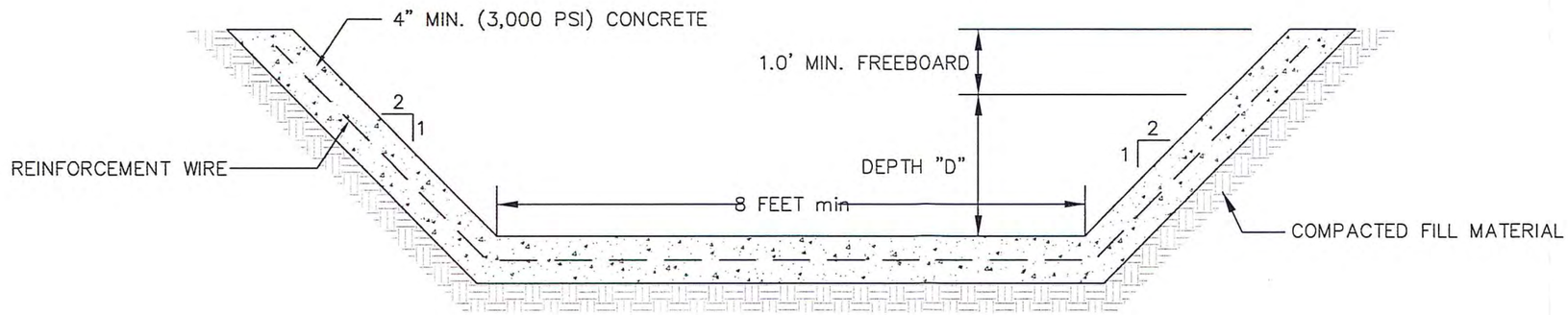
# SEDIMENT BASIN 050 SPILLWAY PROFILE




# TYPICAL SPILLWAY CROSS-SECTION




SPILLWAY FLOW DEPTH "D" = 2.66 FEET (CONTROL SECTION)

SPILLWAY FLOW DEPTH "D" = 0.56 FEET (TAIL DITCH SECTION)

TOTAL SPILLWAY DEPTH "D+1" = 3.66 FEET (CONTROL SECTION)

TOTAL SPILLWAY DEPTH "D+1" = 1.56 FEET (TAIL DITCH SECTION)

NOTE: TOTAL SPILLWAY DEPTH IN TRANSITION SECTION VARIES FROM 3.66 FEET TO 1.56 FEET

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## SPILLWAY CHANNEL SPECIFICATIONS
## SEDIMENT BASIN 050

The entire control section and tail ditch section of the emergency spillway will be cut into the compacted fill of the embankment and lined with a minimum of 4 inches of reinforced concrete. All concrete will be reinforced with 10 gauge, 6" x 6" welded wire mesh. Fibermesh may be added to the concrete for additional strength, however, the addition of fibermesh shall not be used in place of the required 6" x 6" welded wire.

The gradient of the control section of the emergency spillway will not exceed two (2%) percent. The gradient of the tail ditch section of the emergency spillway will not exceed forty (40%) percent.

The control section and tail ditch section of the emergency spillway will extend from the inner face of the embankment, past the centerline of the embankment and be carried out beyond the downstream slope of the embankment.

The concrete liner of the control section of the emergency spillway will be a minimum of 3.66 as measured vertically, allowing 2.66 feet for the maximum anticipated flow and 1.0 feet of dry freeboard. The concrete liner of the tail ditch section of the emergency spillway will be a minimum of 1.56 feet as measured vertically, allowing 0.56 feet for the maximum anticipated flow and 1.0 foot of dry freeboard. There will be a transition zone of at least 20 feet in length between the control section and the tail section. The minimum depth at the beginning of the transition will be 3.66 feet and 1.66 feet at the end of the transition. The flow line of the spillway will be smoothed at the transition to avoid abrupt changes in the flow line slope.

See enclosed SEDCAD 4.0 spillway tail ditch section design and attached Plan Sheet cross-section for the minimum and maximum emergency spillway construction requirements.

A floating silt fence (lightweight turbidity curtain) will be installed near the entrance to the spillway to accomplish sub-surface withdrawal. The floating silt fence (lightweight turbidity curtain) will be set at normal pool and will be anchored at the 10 Year – 24 Hour Event peak stage with steel fence posts.

# Concord Sediment Basin 050 Spillway Control Section

Material: Concrete, Rubble

*Trapezoidal Channel*

| Bottom Width (ft) | Left Sideslope Ratio | Right Sideslope Ratio | Slope (%) | Manning's n | Freeboard Depth (ft) | Freeboard % of Depth | Freeboard Mult. x (VxD) |
|---|---|---|---|---|---|---|---|
| 8.00 | 2.0:1 | 2.0:1 | 2.0 | 0.0220 | 1.00 | | |

| | w/o Freeboard | w/ Freeboard |
|---|---|---|
| Design Discharge: | 136.61 cfs | |
| Depth: | 1.33 ft | 2.33 ft |
| Top Width: | 13.31 ft | 17.31 ft |
| Velocity: | 9.67 fps | |
| X-Section Area: | 14.13 sq ft | |
| Hydraulic Radius: | 1.014 ft | |
| Froude Number: | 1.65 | |

# Concord Sediment Basin 050 Spillway Tail Ditch Section

Material: Concrete, Rubble

*Trapezoidal Channel*

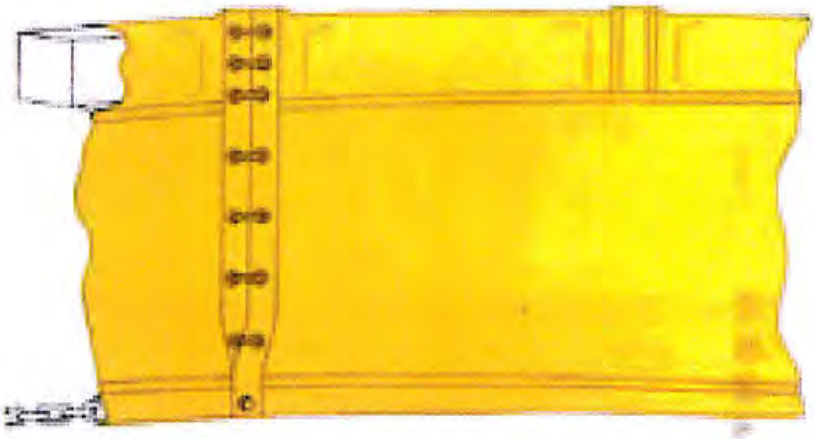
| Bottom Width (ft) | Left Sideslope Ratio | Right Sideslope Ratio | Slope (%) | Manning's n | Freeboard Depth (ft) | Freeboard % of Depth | Freeboard Mult. x (VxD) |
|---|---|---|---|---|---|---|---|
| 8.00 | 2.0:1 | 2.0:1 | 40.0 | 0.0220 | 1.00 | | |

| | w/o Freeboard | w/ Freeboard |
|---|---|---|
| Design Discharge: | 136.61 cfs | |
| Depth: | 0.56 ft | 1.56 ft |
| Top Width: | 10.25 ft | 14.25 ft |
| Velocity: | 26.58 fps | |
| X-Section Area: | 5.14 sq ft | |
| Hydraulic Radius: | 0.489 ft | |
| Froude Number: | 6.61 | |

# SUBSURFACE WITHDRAWAL DEVICE AND FLOATING SILT BOOM

**Lightweight Turbidity Curtain**

Application: Calm waters with little current, such as lakes, ponds, canals and shoreline areas.



## Specifications

- Curtain to be anchored at the maximum anticipated peak stage elevation (10 Year – 24 Hour Precipitation Event).
- PVC coated floatations - ultraviolet resistant
- Geotextile fabric screens
- Chain ballast with connectors
- Double sewn seams with grommets
- Depths per requirements ' 50' sections = Minimum 24" deep
- Fabric - Polyester reinforced vinyl high visibility yellow
- Connector - Sections are laced together through grommets and load lines are bolted together.
- Flotation - 6" expanded polystyrene over 9 lbs./ft. buoyancy.
- Ballast - 1/4" galvanized chain (.7 lbs/ft).

# HYDROLOGY AND SEDIMENTOLOGY PREDICTION
# 10 YEAR - 24 HOUR PRECIPITATION EVENT
# SEDIMENT BASIN 050

# Oak Grove Resources, LLC
# Concord Preparation Plant
# Sediment Basin 050

***10 year - 24 hour event***

Robert W. Usher, P.E.

# *General Information*

## *Storm Information:*

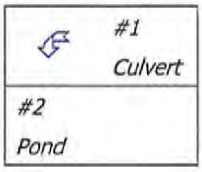
| | |
|---|---|
| Storm Type: | DRN 58 |
| Design Storm: | 10 yr - 24 hr |
| Rainfall Depth: | 6.000 inches |

## *Particle Size Distribution:*

| Size (mm) | cover soil | refuse |
|---|---|---|
| 4.7500 | 100.000% | 100.000% |
| 3.0000 | 78.000% | 47.870% |
| 2.0000 | 63.000% | 29.130% |
| 1.0000 | 47.000% | 12.170% |
| 0.5000 | 30.500% | 5.300% |
| 0.3000 | 19.900% | 3.300% |
| 0.2000 | 14.300% | 1.800% |
| 0.1000 | 7.400% | 0.830% |
| 0.0500 | 5.000% | 0.300% |
| 0.0300 | 3.700% | 0.200% |
| 0.0200 | 1.900% | 0.100% |
| 0.0100 | 0.800% | 0.050% |
| 0.0050 | 0.350% | 0.000% |
| 0.0030 | 0.270% | 0.000% |
| 0.0010 | 0.190% | 0.000% |
| 0.0000 | 0.000% | 0.000% |

# *Structure Networking:*

| Type | Stru # | (flows into) | Stru # | Musk. K (hrs) | Musk. X | Description |
|---|---|---|---|---|---|---|
| Culvert | #1 | ==> | #2 | 0.000 | 0.000 | 42" culverts |
| Pond | #2 | ==> | End | 0.000 | 0.000 | Basin 050 |



# *Structure Summary:*

| | | Immediate Contributing Area (ac) | Total Contributing Area (ac) | Peak Discharge (cfs) | Total Runoff Volume (ac-ft) | Sediment (tons) | Peak Sediment Conc. (mg/l) | Peak Settleable Conc. (ml/l) | 24VW (ml/l) |
|---|---|---|---|---|---|---|---|---|---|
| #1 | | 50.600 | 50.600 | 22.17 | 7.64 | 235.9 | 67,300 | 53.22 | 17.72 |
| #2 | In | 92.900 | 143.500 | 131.60 | 35.89 | 7,274.7 | 252,038 | 199.32 | 112.87 |
| | Out | | | 107.78 | 35.89 | 58.5 | 2,815 | 0.13 | 0.06 |

# *Particle Size Distribution(s) at Each Structure*

## *Structure #1 (42" culverts):*

| Size (mm) | In/Out |
|---|---|
| 4.7500 | 100.000% |
| 3.0000 | 81.703% |
| 2.0000 | 66.035% |
| 1.0000 | 49.288% |
| 0.5000 | 31.985% |
| 0.3000 | 20.869% |
| 0.2000 | 14.996% |
| 0.1000 | 7.760% |
| 0.0500 | 5.243% |
| 0.0300 | 3.880% |
| 0.0200 | 1.992% |
| 0.0100 | 0.839% |
| 0.0050 | 0.367% |
| 0.0030 | 0.283% |
| 0.0010 | 0.199% |
| 0.0000 | 0.000% |

## *Structure #2:*

| Size (mm) | In | Out |
|---|---|---|
| 4.7500 | 100.000% | 100.000% |
| 3.0000 | 82.057% | 100.000% |
| 2.0000 | 66.278% | 100.000% |
| 1.0000 | 49.446% | 100.000% |
| 0.5000 | 32.088% | 100.000% |
| 0.3000 | 20.936% | 100.000% |
| 0.2000 | 15.044% | 100.000% |
| 0.1000 | 7.785% | 100.000% |
| 0.0500 | 5.260% | 100.000% |
| 0.0300 | 3.893% | 100.000% |
| 0.0200 | 1.999% | 100.000% |
| 0.0100 | 0.842% | 100.000% |

| Size (mm) | In | Out |
|---|---|---|
| 0.0050 | 0.368% | 45.803% |
| 0.0030 | 0.284% | 35.334% |
| 0.0010 | 0.200% | 24.865% |
| 0.0000 | 0.000% | 0.000% |

# *Structure Detail:*

*Structure #1 (Culvert)*

*42" culverts*

Culvert Inputs:

| Length (ft) | Slope (%) | Manning's n | Max. Headwater (ft) | Tailwater (ft) | Entrance Loss Coef. (Ke) |
|---|---|---|---|---|---|
| 100.00 | 0.30 | 0.0240 | 2.50 | 0.00 | 0.90 |

Culvert Results:

Design Discharge = 22.17 cfs

Minimum pipe diameter: 1 - 42 inch pipe(s) required

*Structure #2 (Pond)*

*Basin 050*

Pond Inputs:

| | |
|---|---|
| Initial Pool Elev: | 531.90 ft |
| Initial Pool: | 4.05 ac-ft |
| *Sediment Storage: | 9.00 ac-ft |
| Dead Space: | 20.00 % |

**Sediment capacity was entered by user*

Emergency Spillway

| Spillway Elev | Crest Length (ft) | Left Sideslope | Right Sideslope | Bottom Width (ft) |
|---|---|---|---|---|
| 531.90 | 20.00 | 2.00:1 | 2.00:1 | 8.00 |

Pond Results:

| | |
|---|---|
| Peak Elevation: | 534.25 ft |
| H'graph Detention Time: | 1.32 hrs |
| Pond Model: | CSTRS |
| Dewater Time: | 1.22 days |
| Trap Efficiency: | 99.20 % |

*Dewatering time is calculated from peak stage to lowest spillway*

Elevation-Capacity-Discharge Table

| Elevation | Area (ac) | Capacity (ac-ft) | Discharge (cfs) | Dewater Time (hrs) | |
|---|---|---|---|---|---|
| 529.92 | 1.665 | 0.000 | 0.000 | | Top of Sed. Storage |
| 530.00 | 1.690 | 0.132 | 0.000 | | |
| 530.50 | 1.878 | 1.023 | 0.000 | | |
| 531.00 | 2.076 | 2.011 | 0.000 | | |
| 531.50 | 2.284 | 3.101 | 0.000 | | |
| 531.90 | 2.457 | 4.049 | 0.000 | | Spillway #1 |
| 532.00 | 2.500 | 4.297 | 1.337 | 12.70 | |
| 532.50 | 2.621 | 5.577 | 8.025 | 4.50 | |
| 533.00 | 2.744 | 6.918 | 25.040 | 8.55 | |
| 533.50 | 2.871 | 8.321 | 50.766 | 2.35 | |
| 534.00 | 3.000 | 9.789 | 85.964 | 0.80 | |
| 534.25 | 3.065 | 10.545 | 107.783 | 0.40 | Peak Stage |
| 534.50 | 3.131 | 11.322 | 130.207 | | |
| 535.00 | 3.264 | 12.920 | 183.872 | | |
| 535.50 | 3.401 | 14.586 | 247.368 | | |
| 536.00 | 3.540 | 16.322 | 321.111 | | |

## Detailed Discharge Table

| Elevation (ft) | Emergency Spillway (cfs) | Combined Total Discharge (cfs) |
|---|---|---|
| 529.92 | 0.000 | 0.000 |
| 530.00 | 0.000 | 0.000 |
| 530.50 | 0.000 | 0.000 |
| 531.00 | 0.000 | 0.000 |
| 531.50 | 0.000 | 0.000 |
| 531.90 | 0.000 | 0.000 |
| 532.00 | 1.337 | 1.337 |
| 532.50 | 8.025 | 8.025 |
| 533.00 | 25.040 | 25.040 |
| 533.50 | 50.766 | 50.766 |
| 534.00 | 85.964 | 85.964 |
| 534.50 | 130.207 | 130.207 |
| 535.00 | 183.872 | 183.872 |
| 535.50 | 247.368 | 247.368 |
| 536.00 | 321.111 | 321.111 |

# *Subwatershed Hydrology Detail:*

| Stru # | SWS # | SWS Area (ac) | Time of Conc (hrs) | Musk K (hrs) | Musk X | Curve Number | UHS | Peak Discharge (cfs) | Runoff Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| #1 | 1 | 28.400 | 0.850 | 0.012 | 0.374 | 62.000 | S | 8.05 | 3.306 |
| | 2 | 12.900 | 0.510 | 0.000 | 0.000 | 62.000 | S | 4.54 | 1.503 |
| | 3 | 9.300 | 0.210 | 0.000 | 0.000 | 81.000 | F | 11.12 | 2.828 |
| | Σ | **50.600** | | | | | | **22.17** | **7.638** |
| #2 | 1 | 35.000 | 0.290 | 0.000 | 0.000 | 81.000 | F | 41.50 | 10.643 |
| | 2 | 35.000 | 0.290 | 0.000 | 0.000 | 81.000 | F | 41.50 | 10.643 |
| | 3 | 22.900 | 0.300 | 0.000 | 0.000 | 81.000 | F | 27.10 | 6.970 |
| | Σ | **143.500** | | | | | | **131.60** | **35.894** |

# *Subwatershed Sedimentology Detail:*

| Stru # | SWS # | Soil K | L (ft) | S (%) | C | P | PS # | Sediment (tons) | Peak Sediment Conc. (mg/l) | Peak Settleable Conc (ml/l) | 24VW (ml/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | 1 | 0.320 | 200.00 | 3.00 | 0.0030 | 1.0000 | 1 | 0.3 | 109 | 0.09 | 0.06 |
| | 2 | 0.320 | 200.00 | 5.00 | 0.0030 | 1.0000 | 1 | 0.3 | 235 | 0.18 | 0.11 |
| | 3 | 0.320 | 200.00 | 7.00 | 0.9000 | 1.0000 | 1 | 235.3 | 103,725 | 82.03 | 46.96 |
| | Σ | | | | | | | **235.9** | **67,300** | **53.22** | **17.72** |
| #2 | 1 | 0.320 | 200.00 | 15.00 | 0.9000 | 1.0000 | 1 | 3,154.8 | 334,265 | 264.35 | 155.87 |
| | 2 | 0.320 | 200.00 | 15.00 | 0.9000 | 1.0000 | 1 | 3,154.8 | 334,265 | 264.35 | 155.87 |
| | 3 | 0.320 | 200.00 | 8.00 | 0.9000 | 1.0000 | 1 | 729.3 | 129,044 | 102.05 | 58.63 |
| | Σ | | | | | | | **7,274.7** | **252,038** | **199.32** | **112.87** |

# HYDROLOGY AND SEDIMENTOLOGY PREDICTION
# 25 YEAR - 6 HOUR PRECIPITATION EVENT
# SEDIMENT BASIN 050

# Oak Grove Resources, LLC
# Concord Preparation Plant
# Sediment Basin 050

***25 year - 6 hour event***

Robert W. Usher, P.E.

# *General Information*

## *Storm Information:*

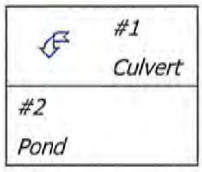
| | |
|---|---|
| Storm Type: | SCS 6 HOUR |
| Design Storm: | 25 yr - 6 hr |
| Rainfall Depth: | 5.000 inches |

## *Particle Size Distribution:*

| Size (mm) | cover soil | refuse |
|---|---|---|
| 4.7500 | 100.000% | 100.000% |
| 3.0000 | 78.000% | 47.870% |
| 2.0000 | 63.000% | 29.130% |
| 1.0000 | 47.000% | 12.170% |
| 0.5000 | 30.500% | 5.300% |
| 0.3000 | 19.900% | 3.300% |
| 0.2000 | 14.300% | 1.800% |
| 0.1000 | 7.400% | 0.830% |
| 0.0500 | 5.000% | 0.300% |
| 0.0300 | 3.700% | 0.200% |
| 0.0200 | 1.900% | 0.100% |
| 0.0100 | 0.800% | 0.050% |
| 0.0050 | 0.350% | 0.000% |
| 0.0030 | 0.270% | 0.000% |
| 0.0010 | 0.190% | 0.000% |
| 0.0000 | 0.000% | 0.000% |

# *Structure Networking:*

| Type | Stru # | (flows into) | Stru # | Musk. K (hrs) | Musk. X | Description |
|---|---|---|---|---|---|---|
| Culvert | #1 | ==> | #2 | 0.000 | 0.000 | 42" culverts |
| Pond | #2 | ==> | End | 0.000 | 0.000 | Basin 050 |



# *Structure Summary:*

| | | Immediate Contributing Area (ac) | Total Contributing Area (ac) | Peak Discharge (cfs) | Total Runoff Volume (ac-ft) | Sediment (tons) | Peak Sediment Conc. (mg/l) | Peak Settleable Conc. (ml/l) | 24VW (ml/l) |
|---|---|---|---|---|---|---|---|---|---|
| #1 | | 50.600 | 50.600 | 29.63 | 5.48 | 308.8 | 126,640 | 100.10 | 31.72 |
| #2 | In | 92.900 | 143.500 | 245.98 | 27.20 | 9,194.7 | 364,530 | 287.98 | 178.37 |
| | Out | | | 136.61 | 27.20 | 101.7 | 5,608 | 0.91 | 0.45 |

# Particle Size Distribution(s) at Each Structure

## Structure #1 (42" culverts):

| Size (mm) | In/Out |
|---|---|
| 4.7500 | 100.000% |
| 3.0000 | 85.781% |
| 2.0000 | 69.312% |
| 1.0000 | 51.745% |
| 0.5000 | 33.605% |
| 0.3000 | 21.927% |
| 0.2000 | 15.757% |
| 0.1000 | 8.154% |
| 0.0500 | 5.509% |
| 0.0300 | 4.077% |
| 0.0200 | 2.094% |
| 0.0100 | 0.881% |
| 0.0050 | 0.386% |
| 0.0030 | 0.298% |
| 0.0010 | 0.209% |
| 0.0000 | 0.000% |

## Structure #2:

| Size (mm) | In | Out |
|---|---|---|
| 4.7500 | 100.000% | 100.000% |
| 3.0000 | 89.359% | 100.000% |
| 2.0000 | 72.175% | 100.000% |
| 1.0000 | 53.846% | 100.000% |
| 0.5000 | 34.944% | 100.000% |
| 0.3000 | 22.799% | 100.000% |
| 0.2000 | 16.383% | 100.000% |
| 0.1000 | 8.478% | 100.000% |
| 0.0500 | 5.728% | 100.000% |
| 0.0300 | 4.239% | 100.000% |
| 0.0200 | 2.177% | 100.000% |
| 0.0100 | 0.917% | 82.895% |

| Size (mm) | In | Out |
|---|---|---|
| 0.0050 | 0.401% | 36.266% |
| 0.0030 | 0.309% | 27.977% |
| 0.0010 | 0.218% | 19.687% |
| 0.0000 | 0.000% | 0.000% |

# *Structure Detail:*

*Structure #1 (Culvert)*

*42" culverts*

Culvert Inputs:

| Length (ft) | Slope (%) | Manning's n | Max. Headwater (ft) | Tailwater (ft) | Entrance Loss Coef. (Ke) |
|---|---|---|---|---|---|
| 100.00 | 0.30 | 0.0240 | 2.50 | 0.00 | 0.90 |

Culvert Results:

Design Discharge = 29.63 cfs

Minimum pipe diameter: 1 - 54 inch pipe(s) required

*Structure #2 (Pond)*

*Basin 050*

Pond Inputs:

| | |
|---|---|
| Initial Pool Elev: | 531.90 ft |
| Initial Pool: | 4.05 ac-ft |
| *Sediment Storage: | 9.00 ac-ft |
| Dead Space: | 20.00 % |

**Sediment capacity was entered by user*

Emergency Spillway

| Spillway Elev | Crest Length (ft) | Left Sideslope | Right Sideslope | Bottom Width (ft) |
|---|---|---|---|---|
| 531.90 | 20.00 | 2.00:1 | 2.00:1 | 8.00 |

Pond Results:

| | |
|---|---|
| Peak Elevation: | 534.56 ft |
| H'graph Detention Time: | 1.00 hrs |
| Pond Model: | CSTRS |
| Dewater Time: | 0.92 days |
| Trap Efficiency: | 98.89 % |

*Dewatering time is calculated from peak stage to lowest spillway*

Elevation-Capacity-Discharge Table

| Elevation | Area (ac) | Capacity (ac-ft) | Discharge (cfs) | Dewater Time (hrs) | |
|---|---|---|---|---|---|
| 529.92 | 1.665 | 0.000 | 0.000 | | Top of Sed. Storage |
| 530.00 | 1.690 | 0.132 | 0.000 | | |
| 530.50 | 1.878 | 1.023 | 0.000 | | |
| 531.00 | 2.076 | 2.011 | 0.000 | | |
| 531.50 | 2.284 | 3.101 | 0.000 | | |
| 531.90 | 2.457 | 4.049 | 0.000 | | Spillway #1 |
| 532.00 | 2.500 | 4.297 | 1.337 | 12.65 | |
| 532.50 | 2.621 | 5.577 | 8.025 | 4.80 | |
| 533.00 | 2.744 | 6.918 | 25.040 | 1.25 | |
| 533.50 | 2.871 | 8.321 | 50.766 | 1.10 | |
| 534.00 | 3.000 | 9.789 | 85.964 | 1.35 | |
| 534.50 | 3.131 | 11.322 | 130.207 | 0.80 | |
| 534.56 | 3.148 | 11.512 | 136.607 | 0.15 | Peak Stage |
| 535.00 | 3.264 | 12.920 | 183.872 | | |
| 535.50 | 3.401 | 14.586 | 247.368 | | |
| 536.00 | 3.540 | 16.322 | 321.111 | | |

## Detailed Discharge Table

| Elevation (ft) | Emergency Spillway (cfs) | Combined Total Discharge (cfs) |
|---|---|---|
| 529.92 | 0.000 | 0.000 |
| 530.00 | 0.000 | 0.000 |
| 530.50 | 0.000 | 0.000 |
| 531.00 | 0.000 | 0.000 |
| 531.50 | 0.000 | 0.000 |
| 531.90 | 0.000 | 0.000 |
| 532.00 | 1.337 | 1.337 |
| 532.50 | 8.025 | 8.025 |
| 533.00 | 25.040 | 25.040 |
| 533.50 | 50.766 | 50.766 |
| 534.00 | 85.964 | 85.964 |
| 534.50 | 130.207 | 130.207 |
| 535.00 | 183.872 | 183.872 |
| 535.50 | 247.368 | 247.368 |
| 536.00 | 321.111 | 321.111 |

# *Subwatershed Hydrology Detail:*

| Stru # | SWS # | SWS Area (ac) | Time of Conc (hrs) | Musk K (hrs) | Musk X | Curve Number | UHS | Peak Discharge (cfs) | Runoff Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| #1 | 1 | 28.400 | 0.850 | 0.012 | 0.374 | 62.000 | S | 8.39 | 2.275 |
| | 2 | 12.900 | 0.510 | 0.000 | 0.000 | 62.000 | S | 4.74 | 1.034 |
| | 3 | 9.300 | 0.210 | 0.000 | 0.000 | 81.000 | F | 23.46 | 2.174 |
| | Σ | **50.600** | | | | | | **29.63** | **5.483** |
| #2 | 1 | 35.000 | 0.290 | 0.000 | 0.000 | 81.000 | F | 81.91 | 8.181 |
| | 2 | 35.000 | 0.290 | 0.000 | 0.000 | 81.000 | F | 81.91 | 8.181 |
| | 3 | 22.900 | 0.300 | 0.000 | 0.000 | 81.000 | F | 53.17 | 5.358 |
| | Σ | **143.500** | | | | | | **245.98** | **27.203** |

# *Subwatershed Sedimentology Detail:*

| Stru # | SWS # | Soil K | L (ft) | S (%) | C | P | PS # | Sediment (tons) | Peak Sediment Conc. (mg/l) | Peak Settleable Conc (ml/l) | 24VW (ml/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | 1 | 0.320 | 200.00 | 3.00 | 0.0030 | 1.0000 | 1 | 0.3 | 108 | 0.08 | 0.07 |
| | 2 | 0.320 | 200.00 | 5.00 | 0.0030 | 1.0000 | 1 | 0.2 | 222 | 0.17 | 0.13 |
| | 3 | 0.320 | 200.00 | 7.00 | 0.9000 | 1.0000 | 1 | 308.4 | 153,889 | 121.64 | 78.70 |
| | Σ | | | | | | | **308.8** | **126,640** | **100.10** | **31.72** |
| #2 | 1 | 0.320 | 200.00 | 15.00 | 0.9000 | 1.0000 | 1 | 3,983.9 | 451,663 | 356.82 | 243.94 |
| | 2 | 0.320 | 200.00 | 15.00 | 0.9000 | 1.0000 | 1 | 3,983.9 | 451,663 | 356.82 | 243.94 |
| | 3 | 0.320 | 200.00 | 8.00 | 0.9000 | 1.0000 | 1 | 918.0 | 179,552 | 141.84 | 94.20 |
| | Σ | | | | | | | **9,194.7** | **364,530** | **287.98** | **178.37** |

# STABILITY ANALYSIS - COMPUTER OUTPUT
# SEDIMENT BASIN 050 - STATIC

## STABILITY ANALYSIS PROCEDURE

The computer program used to analyze the slope stability was the REAME Slope Stability Program as developed by Dr. Yang H. Huang, P.E. of the University of Kentucky.

The soil type of the foundation material beneath the proposed embankment structure of Sediment Basin 050 was sampled, analyzed and classified by personnel of McGehee Engineering Corp. The depth to the stiff base of Sediment Basin 050 (3') was measured by personnel of McGehee Engineering Corp.

The soil type to be used in the construction of the proposed embankment structure of Sediment Basins 050 was sampled, analyzed and classified by personnel of McGehee Engineering Corp. This sample of material was taken upstream within the adjacent pool area. From laboratory testing either material types are satisfactory for construction of the embankment. The analysis used the material with the lesser strength values.

### SOIL PROPERTIES

| USAGE | TYPE | COHESION (psf) | INTERNAL ANGLE OF FRICTION | EFFECTIVE DENSITY (pcf) |
|---|---|---|---|---|
| 050 FOUND. | SM | 270.00 | 33.02 | 132.14 |
| 050 DAM | SM-SC | 180.00 | 30.54 | 135.96 |

### ANALYSIS RESULTS

| BASIN | STATIC SAFETY FACTOR |
|---|---|
| 050 | 1.66 |

# SIEVE ANALYSIS

(ASTM C136-96a)

**Company Name:** Cliffs Natural Resources
**Location:** Concord
**Sample I.D.:** Basin 050 UPSTREAM
**Description:** Dam Material

**Sample Date:** 5/12/11
**Analyzed By:** JW
**Date Analyzed:** 5/16/11
**Requested By:** R. Usher

**Weight of Oven Dry Sample (W):** **1014.0 Grams**

| Sieve No. | Sieve + Sample Weight | Sieve Weight | Sample Weight Retained | Percent of Total Retained | Cumulative Weight Percent | Percent Retained | Percent Finer |
|---|---|---|---|---|---|---|---|
| 1" | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 3/4" | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 1/2" | 566.0 | 540.0 | 26.0 | 2.6 | 2.6 | 2.6 | 97.4 |
| 4 | 644.0 | 513.0 | 131.0 | 12.9 | 15.5 | 15.5 | 84.5 |
| 10 | 638.0 | 462.0 | 176.0 | 17.4 | 32.8 | 32.8 | 67.2 |
| 40 | 694.0 | 383.0 | 311.0 | 30.7 | 63.5 | 63.5 | 36.5 |
| 200 | 504.2 | 333.0 | 171.2 | 16.9 | 80.4 | 80.4 | 19.6 |
| Pan | 578.8 | 380.0 | 198.8 | 19.6 | 100.0 | 100.0 | 0.0 |
| | **Total Weight (W1):** | | 1014.0 | | | | |

# SOIL CLASSIFICATION

Unified System (ASTM D-2487)

**Liquid Limit:** 22.3
**Plastic Limit:** 17.4
**Plasticity Index:** 4.9

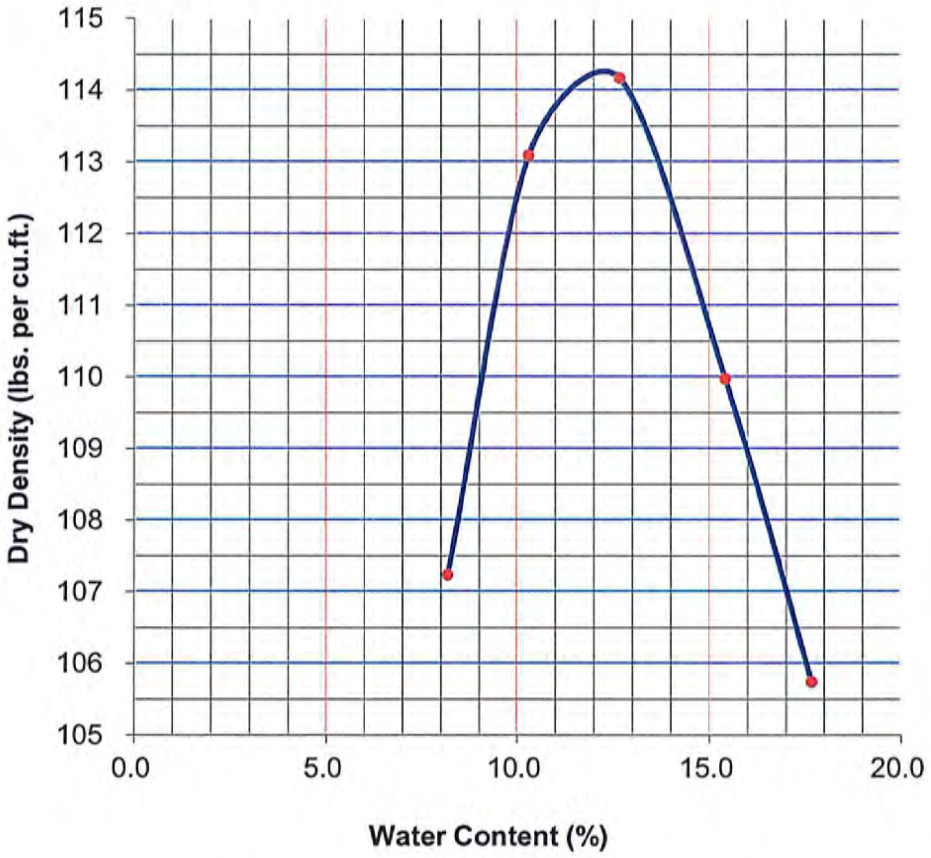
**Soil Classification:** **SM-SC**

Coarse Grained
Silty, Clayey Sand

**Effective Cohesion:** 1.2500 psi
**Total Cohesion:** 1.940 psi
**Permeability:** 1.40 ft/yr
**Maximum Dry Density:** 120.0 pcf
**Optimum Moisture:** 13.3 %
**Effective Cohesion:** 180.0 psf
**Angle of Internal Friction:** 30.54 degrees
**Mass Unit Weight:** 135.96 pcf

mcgehee engineering corp

Cliffs Natural Resources
Concord, Basin 050 UPSTREAM, Dam Material
Moisture Density Relationship
(Proctor Method)




| ASTM D-698 Method C | Water Content % | Specific Gravity | %> No. 4 | %< No. 200 | LL % | PL % | PI % |
|---|---|---|---|---|---|---|---|
| | | | 15.50 | 19.60 | 22.3 | 17.4 | 4.9 |

| Sample Description, Classification and Location | Sample No.: | Basin 050 UPSTREAM Dam Material |
|---|---|---|
| **Coarse Grained Silty Clayey Sand** | Optimum Moisture Content= | 12.3 |
| | Maximum Dry Density = | 114.3 |

mcgehee engineering corp

# SIEVE ANALYSIS

(ASTM C136-96a and C117)

**Company Name:** Cliffs
**Location:** Concord Prep Plant
**Sample I.D.:** Basin 050
**Description:** Foundation

**Sample Date:** 4/22/15
**Analyzed By:** JWW
**Date Analyzed:** 4/27/15
**Requested By:** B Usher

**Weight of Oven Dry Sample (W):** **1012.0 Grams**

| Sieve No. | Sieve + Sample Weight | Sieve Weight | Sample Weight Retained | Percent of Total Retained | Cumulative Weight Percent | Percent Retained | Percent Finer |
|---|---|---|---|---|---|---|---|
| 1" | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 3/4" | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 1/2" | 583.6 | 537.9 | 45.7 | 4.5 | 4.5 | 4.5 | 95.5 |
| 4 | 609.8 | 512.4 | 97.4 | 9.5 | 14.0 | 14.0 | 86.0 |
| 10 | 516.9 | 460.5 | 56.4 | 5.5 | 19.5 | 19.5 | 80.5 |
| 40 | 517.3 | 382.0 | 135.3 | 13.2 | 32.8 | 32.8 | 67.2 |
| 200 | 676.1 | 332.2 | 343.9 | 33.6 | 66.4 | 66.4 | 33.6 |
| Pan | 718.6 | 375.2 | 343.4 | 33.6 | 100.0 | 100.0 | 0.0 |
| | | **Total Weight (W1):** | 1022.1 | | | | |

# SOIL CLASSIFICATION

Unified System (ASTM D-2487)

**Liquid Limit:** 15.7
**Plastic Limit:** 13.9
**Plasticity Index:** 1.8

**Soil Classification:** SM

Coarse Grained
Silty sand

**Effective Cohesion:** 1.8750 psi
**Total Cohesion:** 6.528 psi
**Permeability:** 12.30 ft/yr
**Maximum Dry Density:** 115.0 pcf
**Optimum Moisture:** 14.9 %
**Effective Cohesion:** 270.0 psf
**Angle of Internal Friction:** 33.02 degrees
**Mass Unit Weight:** 132.14 pcf

Post Office Box 3431 • 450 19th Street • Jasper, Alabama 35502-3431 • 205-221-0686 • Fax 205-221-7721 • staff@mcgehee.org

# REAME
## (Rotational Equilibrium Analysis of Multilayered Embankments)

## Oak Grove Resources, LLC
## Concord Preparation Plant, P-3233
## Sediment Basin 050
## Static Case

Oak Grove Resources, LLC Concord Prep Plant Sediment Basin 050

Number of cases to be analyzed 1

Case Number 1

Number of boundary lines= 4
Number of points on boundary lines are: 2 2 3 7

On boundary line no. 1 Point no. and coordinates are:
1 .000 25.000 2 500.000 .000

On boundary line no. 2 Point no. and coordinates are:
1 200.000 18.000 2 354.286 10.286

On boundary line no. 3 Point no. and coordinates are:
1 .000 28.000 2 200.000 18.000 3 249.750 37.900

On boundary line no. 4 Point no. and coordinates are:
1 .000 37.900 2 249.750 37.900 3 261.500 42.600 4 273.500 42.600 5 338.407 16.637
6 354.286 10.286 7 500.000 3.000

Line no. and slope of each segment are:
1 -.050
2 -.050
3 -.050 .400
4 .000 .400 .000 -.400 -.400 -.050

No. of radius control zones= 1 Plot or no plot= 1 No. of seepage cases= 1

Total no. of lines at bottom of radius control zones is: 1

For rad. cont. zone no. 1 Radius decrement= .000 No. of Circles= 5 Id no. for first circle=, 1
Line no.= 1 Begin pt. no.= 1 End pt. no.= 2

| Soil no. | Cohesion | F. angle | Unit wt. |
|---|---|---|---|
| 1 | 270.000 | 33.020 | 132.140 |
| 2 | 180.000 | 30.540 | 135.960 |
| 3 | .000 | .000 | 62.400 |

Seismic coefficient= .000 Min. depth of tallest slice= .000 Unit weight of water= 62.400

The factors of safety are determined by the SIMPLIFIED BISHOP method

NSPG= 1 NSRCH= 0 No. of slices= 10 No. of add. radii= 2

No. of points on water table for each case= 6

Under seepage condition 1point no. and coordinates of water table are:
1 .000 37.900 2 249.750 37.900 3 286.616 30.444 4 338.407 16.637 5 354.286 10.286
6 500.000 3.000

point1=( 274.000, 64.000) point2=( 274.000, 44.000) point3=( 355.000, 44.000) NJ= 2 NI= 2
Automatic search will follow after grid with XINC= 10.000 and YINC= 10.000

At point ( 274.000, 64.000) under seepage 1,the radius and the corresponding factor of safety are:
52.634 9.109 46.389 8.495 40.143 8.579 33.897 8.562 27.652 8.467
50.552 8.870 48.470 8.514 44.307 8.570 42.225 8.612 25.570 9.404
23.488 15.125
Lowest factor of safety= 8.467 and occurs at radius = 27.652

At point ( 274.000, 54.000) under seepage 1,the radius and the corresponding factor of safety are:
42.647 9.251 36.400 8.544 30.152 8.176 23.905 7.673 17.658 7.575
15.576 8.742 13.493 13.161
Lowest factor of safety= 7.575 and occurs at radius = 17.658

At point ( 274.000, 44.000) under seepage 1,the radius and the corresponding factor of safety are:
32.659 10.028 26.425 9.080 20.190 8.188 13.956 8.281 7.721 9.179
24.347 8.603 22.268 8.370 18.112 8.122 16.034 8.024
Lowest factor of safety= 8.024 and occurs at radius = 16.034

At point ( 314.500, 64.000) under seepage 1,the radius and the corresponding factor of safety are:
54.657 1.959 50.745 1.846 46.833 1.976 42.921 2.290 39.009 3.092
53.353 1.936 52.049 1.886 49.441 1.876 48.137 1.917
Lowest factor of safety= 1.846 and occurs at radius = 50.745

At point ( 314.500, 54.000) under seepage 1,the radius and the corresponding factor of safety are:
44.669 2.046 40.898 1.936 37.126 2.076 33.355 2.392 29.583 3.224
43.412 2.032 42.155 1.985 39.641 1.970 38.383 2.015
Lowest factor of safety= 1.936 and occurs at radius = 40.898

At point ( 314.500, 44.000) under seepage 1,the radius and the corresponding factor of safety are:
34.682 2.264 31.051 2.151 27.420 2.280 23.789 2.590 20.158 3.443
33.471 2.255 32.261 2.220 29.840 2.183 28.630 2.224
Lowest factor of safety= 2.151 and occurs at radius = 31.051

At point ( 355.000, 64.000) under seepage 1,the radius and the corresponding factor of safety are:
56.679 2.558 55.371 2.676 54.063 2.759 52.754 3.063 51.446 5.146
Lowest factor of safety= 2.558 and occurs at radius = 56.679

At point ( 355.000, 54.000) under seepage 1,the radius and the corresponding factor of safety are:
46.692 2.802 45.524 2.955 44.356 3.144 43.189 3.244 42.021 5.523
Lowest factor of safety= 2.802 and occurs at radius = 46.692

At point ( 355.000, 44.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 36.704 | 3.146 | 35.677 | 3.363 | 34.650 | 3.677 | 33.623 | 3.514 | 32.595 | 6.065 |
| 34.307 | 3.789 | 33.965 | 3.834 | 33.280 | 4.021 | 32.938 | 4.784 | | |

Lowest factor of safety= 3.146 and occurs at radius = 36.704

For piezometric line No. 1

At point ( 314.500, 64.000) ,RADIUS 50.745
the minimum factor of safety is 1.846

At point ( 314.500, 64.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 54.657 | 1.959 | 50.745 | 1.846 | 46.833 | 1.976 | 42.921 | 2.290 | 39.009 | 3.092 |
| 53.353 | 1.936 | 52.049 | 1.886 | 49.441 | 1.876 | 48.137 | 1.917 | | |

Lowest factor of safety= 1.846 and occurs at radius = 50.745

At point ( 324.500, 64.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 55.156 | 1.840 | 51.887 | 1.759 | 48.618 | 1.938 | 45.349 | 2.311 | 42.080 | 3.316 |
| 54.066 | 1.838 | 52.977 | 1.824 | 50.797 | 1.804 | 49.708 | 1.863 | | |

Lowest factor of safety= 1.759 and occurs at radius = 51.887

At point ( 334.500, 64.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 55.655 | 1.830 | 53.029 | 1.833 | 50.403 | 1.948 | 47.777 | 2.368 | 45.151 | 3.634 |

Lowest factor of safety= 1.830 and occurs at radius = 55.655

At point ( 324.500, 74.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 65.144 | 1.793 | 61.734 | 1.713 | 58.324 | 1.890 | 54.915 | 2.263 | 51.505 | 3.213 |
| 64.007 | 1.790 | 62.871 | 1.769 | 60.597 | 1.756 | 59.461 | 1.816 | | |

Lowest factor of safety= 1.713 and occurs at radius = 61.734

At point ( 324.500, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 75.131 | 1.795 | 71.581 | 1.702 | 68.031 | 1.860 | 64.480 | 2.227 | 60.930 | 3.126 |
| 73.948 | 1.785 | 72.764 | 1.756 | 70.397 | 1.741 | 69.214 | 1.794 | | |

Lowest factor of safety= 1.702 and occurs at radius = 71.581

At point ( 324.500, 94.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 85.119 | 1.823 | 81.428 | 1.728 | 77.737 | 1.869 | 74.046 | 2.196 | 70.355 | 3.051 |
| 83.888 | 1.814 | 82.658 | 1.777 | 80.198 | 1.763 | 78.967 | 1.807 | | |

Lowest factor of safety= 1.728 and occurs at radius = 81.428

At point ( 334.500, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 75.631 | 1.730 | 72.723 | 1.713 | 69.816 | 1.876 | 66.909 | 2.300 | 64.001 | 3.435 |
| 74.661 | 1.738 | 73.692 | 1.745 | 71.754 | 1.732 | 70.785 | 1.799 | | |

Lowest factor of safety= 1.713 and occurs at radius = 72.723

At point ( 314.500, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 74.632 | 1.993 | 70.439 | 1.869 | 66.245 | 1.972 | 62.052 | 2.225 | 57.859 | 2.921 |
| 73.234 | 1.962 | 71.836 | 1.895 | 69.041 | 1.890 | 67.643 | 1.924 | | |

Lowest factor of safety= 1.869 and occurs at radius = 70.439

At point ( 327.000, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 75.256 | 1.762 | 71.866 | 1.686 | 68.477 | 1.855 | 65.087 | 2.242 | 61.698 | 3.191 |
| 74.126 | 1.758 | 72.996 | 1.741 | 70.737 | 1.728 | 69.607 | 1.785 | | |

Lowest factor of safety= 1.686 and occurs at radius = 71.866

At point ( 329.500, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 75.381 | 1.742 | 72.152 | 1.678 | 68.923 | 1.857 | 65.694 | 2.258 | 62.466 | 3.264 |
| 74.305 | 1.743 | 73.228 | 1.735 | 71.076 | 1.723 | 70.000 | 1.783 | | |

Lowest factor of safety= 1.678 and occurs at radius = 72.152

At point ( 332.000, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 75.506 | 1.732 | 72.438 | 1.674 | 69.370 | 1.864 | 66.302 | 2.277 | 63.233 | 3.344 |
| 74.483 | 1.736 | 73.460 | 1.737 | 71.415 | 1.728 | 70.392 | 1.789 | | |

Lowest factor of safety= 1.674 and occurs at radius = 72.438

At point ( 334.500, 84.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 75.631 | 1.730 | 72.723 | 1.713 | 69.816 | 1.876 | 66.909 | 2.300 | 64.001 | 3.435 |
| 74.661 | 1.738 | 73.692 | 1.745 | 71.754 | 1.732 | 70.785 | 1.799 | | |

Lowest factor of safety= 1.713 and occurs at radius = 72.723

At point ( 332.000, 86.500) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 78.003 | 1.729 | 74.899 | 1.670 | 71.796 | 1.857 | 68.693 | 2.269 | 65.590 | 3.321 |
| 76.968 | 1.732 | 75.934 | 1.731 | 73.865 | 1.721 | 72.831 | 1.782 | | |

Lowest factor of safety= 1.670 and occurs at radius = 74.899

At point ( 332.000, 89.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 80.499 | 1.727 | 77.361 | 1.667 | 74.223 | 1.851 | 71.084 | 2.262 | 67.946 | 3.297 |
| 79.453 | 1.729 | 78.407 | 1.727 | 76.315 | 1.716 | 75.269 | 1.775 | | |

Lowest factor of safety= 1.667 and occurs at radius = 77.361

At point ( 332.000, 91.500) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 82.996 | 1.726 | 79.823 | 1.665 | 76.649 | 1.845 | 73.476 | 2.255 | 70.302 | 3.275 |
| 81.938 | 1.728 | 80.881 | 1.724 | 78.765 | 1.713 | 77.707 | 1.771 | | |

Lowest factor of safety= 1.665 and occurs at radius = 79.823

At point ( 332.000, 94.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 85.493 | 1.730 | 82.285 | 1.665 | 79.076 | 1.839 | 75.867 | 2.248 | 72.659 | 3.253 |
| 84.424 | 1.728 | 83.354 | 1.723 | 81.215 | 1.712 | 80.146 | 1.768 | | |

Lowest factor of safety= 1.665 and occurs at radius = 82.285

At point ( 334.500, 91.500) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 83.121 | 1.719 | 80.108 | 1.663 | 77.096 | 1.856 | 74.083 | 2.277 | 71.070 | 3.360 |
| 82.117 | 1.723 | 81.113 | 1.725 | 79.104 | 1.717 | 78.100 | 1.778 | | |

Lowest factor of safety= 1.663 and occurs at radius = 80.108

At point ( 337.000, 91.500) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 83.246 | 1.720 | 80.394 | 1.714 | 77.542 | 1.872 | 74.690 | 2.303 | 71.838 | 3.455 |
| 82.295 | 1.727 | 81.345 | 1.734 | 79.443 | 1.725 | 78.493 | 1.790 | | |

Lowest factor of safety= 1.714 and occurs at radius = 80.394

At point ( 334.500, 94.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 85.618 | 1.718 | 82.570 | 1.661 | 79.522 | 1.851 | 76.474 | 2.270 | 73.427 | 3.336 |
| 84.602 | 1.721 | 83.586 | 1.722 | 81.554 | 1.713 | 80.538 | 1.772 | | |

Lowest factor of safety= 1.661 and occurs at radius = 82.570

At point ( 334.500, 96.500) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 88.115 | 1.718 | 85.032 | 1.660 | 81.949 | 1.844 | 78.866 | 2.264 | 75.783 | 3.313 |
| 87.087 | 1.721 | 86.060 | 1.719 | 84.004 | 1.711 | 82.977 | 1.768 | | |

Lowest factor of safety= 1.660 and occurs at radius = 85.032

At point ( 334.500, 99.000) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 90.612 | 1.722 | 87.494 | 1.660 | 84.375 | 1.839 | 81.257 | 2.257 | 78.139 | 3.291 |
| 89.572 | 1.721 | 88.533 | 1.719 | 86.454 | 1.710 | 85.415 | 1.766 | | |

Lowest factor of safety= 1.660 and occurs at radius = 87.494

At point ( 337.000, 96.500) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 88.240 | 1.716 | 85.317 | 1.691 | 82.395 | 1.860 | 79.473 | 2.289 | 76.551 | 3.404 |
| 87.266 | 1.720 | 86.292 | 1.723 | 84.343 | 1.714 | 83.369 | 1.779 | | |

Lowest factor of safety= 1.691 and occurs at radius = 85.317

At point ( 332.000, 96.500) under seepage 1,the radius and the corresponding factor of safety are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 87.990 | 1.736 | 84.746 | 1.667 | 81.503 | 1.837 | 78.259 | 2.241 | 75.015 | 3.232 |
| 86.909 | 1.732 | 85.828 | 1.723 | 83.665 | 1.712 | 82.584 | 1.768 | | |

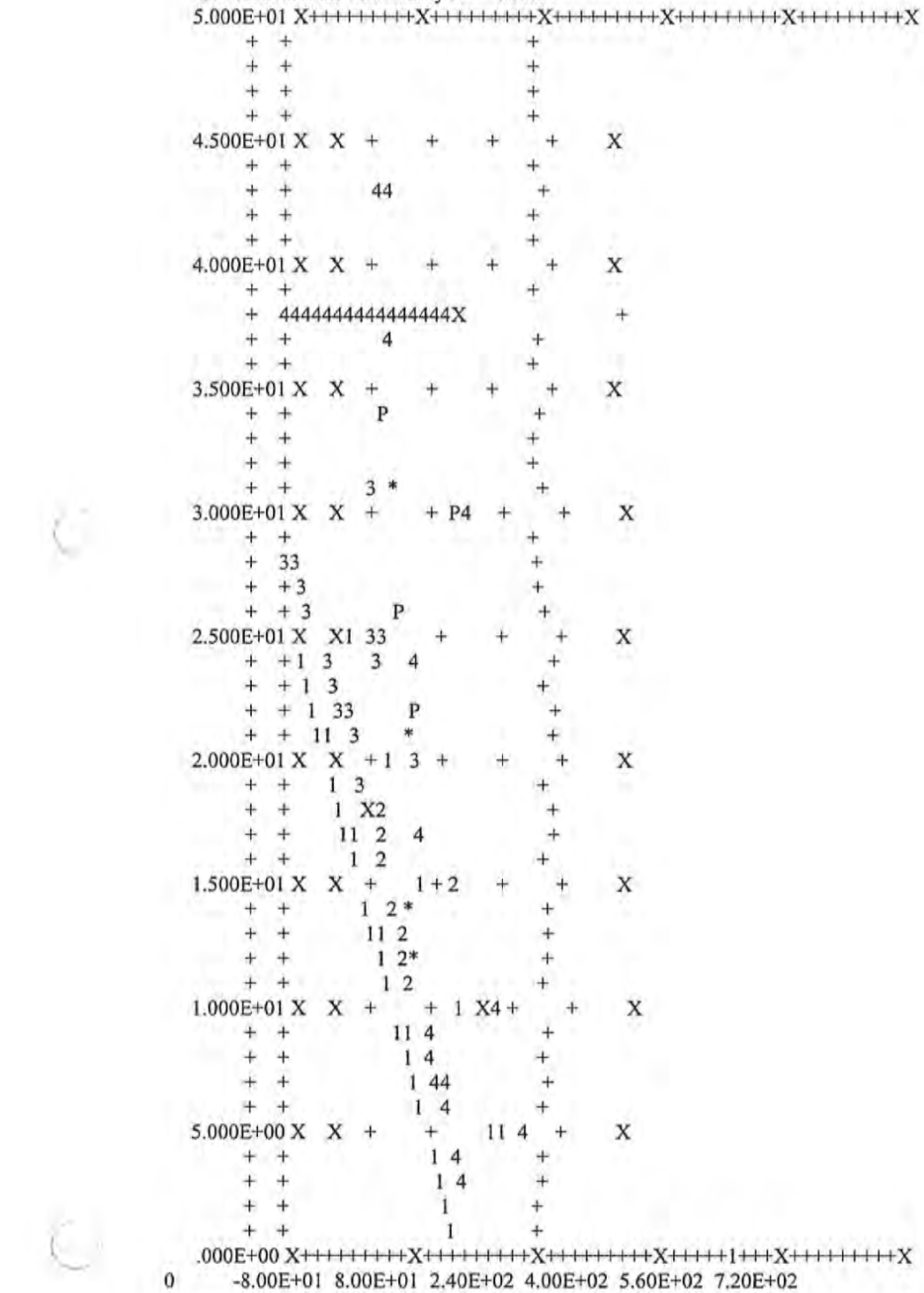
Lowest factor of safety= 1.667 and occurs at radius = 84.746

For piezometric line No. 1

At point ( 334.500, 96.500) ,RADIUS 85.032
the minimum factor of safety is 1.660

1

Cross section in distorted scale. Numerals indicate boundary line no.
If there area more than 10 bound. lines, alphabets will then be used. P indicates
Piezometric line. If a portion of Piezometric line coincides with
the ground or another boundary line, only the ground or boundary
line will be shown. X indicates intersection of two boundary
lines. * indicates failure surface.
The minimum factor of safety is 1.660



mcgehee engineering corp

July 10, 2015

Mr.Stephen Miles, P.E.
**Alabama Surface Mining Commission**
P. O. Box 2390
Jasper, AL 35502-2390

RE: **Oak Grove Resources, LLC**
Concord Preparation Plant, P-3233

Dear Mr. Miles:

I hereby certify the enclosed detailed design plans for Sediment Basin 051 for the above referenced mine are in accordance with the Regulations of the Alabama Surface Mining Commission as adopted by Act 81-435 of December 18, 1981 and as amended to date and that the information used in the enclosed basin design plans is true and correct to the best of my knowledge and belief.

If you have any questions or need additional information, please do not hesitate to contact our office.

Sincerely,

**McGehee Engineering Corp.**

ALABAMA LICENSED PROFESSIONAL No. 15917 ENGINEER ROBERT W. USHER

Robert W. Usher, P.E.
Alabama Reg. No. 15917

Post Office Box 3431 • 450 19th Street West • Jasper, Alabama 35502-3431 • 205-221-0686 • Fax 205-221-7721 • staff@mcgehee.org

## SEDIMENT BASIN CONSTRUCTION SPECIFICATIONS

Sediment basins (temporary or permanent) will be designed and constructed using the following as minimum specifications:

### 1. EMBANKMENT REQUIREMENTS

A) The minimum width of the top of the embankment will under no circumstance be less than twelve (12) feet.

B) The embankment will have a minimum front and back slope no steeper than the slopes listed on the detailed design sheet.

C) The foundation area of the embankment will be cleared and grubbed of all organic matter with no surface slope steeper than 1 horizontal to 1 vertical. The entire wet area, as measured from the upstream toe of the embankment to the normal pool level, will be cleared of trees and large brush.

D) A core will be constructed in a cutoff trench along the centerline of the embankment. The cutoff trench will be of suitable depth and width to attain relatively impervious material.

E) The embankment construction material will be free of sod, roots, stumps, rocks, etc., which exceed six (6") inches in diameter. The embankment material will be placed in layers of twelve (12") inches or less and compacted to ninety five (95%) percent of the standard proctor density, as set forth in ASTM.

F) The embankment, foundation and abutments will be designed and constructed to be stable under normal construction and operating conditions, with a minimum static safety factor of 1.3 at normal pool level with steady seepage saturation conditions.

G) The actual constructed height of the embankment will be a minimum of five (5%) percent higher than the design height to allow for settling over the life of the embankment.

H) The design embankment height for temporary impoundments will be a minimum of one (1) foot above the maximum water level anticipated from a 10 Year - 24 Hour or a 25 Year - 6 Hour precipitation event (whichever is greater). The design embankment height for permanent impoundments will be a minimum of one (1) foot above the maximum water level anticipated from a 10 Year - 24 Hour or a 25 Year - 6 Hour precipitation event (whichever is greater).

I) For embankments constructed as point source discharges, the embankment will be constructed and abutments keyed into undisturbed, virgin, ground if at all possible. In the event that this can not be achieved, additional design and construction specifications will be submitted in the detailed design plans.

J) The embankment and all areas disturbed in the construction of the embankment will be seeded with a mixture of perennial and annual grasses, fertilized and mulched to prevent erosion and ensure restabilization. Hay dams, silt fences, rock check dams, etc. will be installed, where deemed necessary, as additional erosion prevention methods.

## 2. DISCHARGE STRUCTURE REQUIREMENTS

A) The primary spillway will be designed to adequately carry the anticipated peak runoff from a 10 Year - 24 Hour precipitation event. The combination primary and secondary (emergency) spillway system will be designed to safely carry the anticipated peak runoff from a 25 Year - 6 Hour precipitation event. When sediment basins are proposed in the drainage course of a public water supply, the spillway system will be designed and constructed to adequately carry the runoff from a 50 Year - 24 Hour precipitation event.

B) Channel linings, for secondary (emergency) spillways will be a trapezoidal open channel constructed in natural ground and planted with a mixture of both annual and perennial grasses being predominantly fescue and bermuda. In the event that the spillway can not be constructed in natural ground the spillway will be lined with riprap, concrete, asphalt or durable rock (See Detailed Design Plans for Spillway Lining).

C) When consisting of pipe, the primary spillway will be installed according to Class "C" pipe installation for embankment bedding.

D) Sediment basins with a single spillway system, such as a skimmer board, will be a trapezoidal open channel constructed in consolidated, nonerodible material and lined with rip-rap, concrete, asphalt or durable rock (See Detailed Design Plans for Spillway Lining).

E) The primary spillway will be designed and constructed with device to eliminate floating solids from leaving the impoundment. This device will consist of a turned down elbow when using pipe or a skimmer system when using an open channel spillway.

F) When necessary, to prevent erosion of the embankment or discharge area, a splash pad of rip-rap, durable rock, sacrete, etc. will be installed at the discharge end of the primary spillway.

G) The combined spillway systems, for sediment basins constructed in series, will be designed to adequately accommodate the entire drainage area.

## 3. INSPECTION, MAINTENANCE AND CERTIFICATION REQUIREMENTS

A) Inspections will be conducted regularly during construction of the sediment basin by a qualified registered professional engineer or other qualified person under the direction of a professional engineer. Upon completion of construction, the sediment basin will be certified, by a qualified registered professional engineer, to the Regulatory Authority as having been constructed in accordance with the approved detailed design plans.

B) Sediment basins will be inspected semi-monthly for erosion, instability, etc., with maintenance performed as necessary, until the removal of the structure or until a Phase III Bond Release is granted.

C) Sediment basins will be examined quarterly for structural weakness, instability, erosion, slope failure, or other hazardous conditions with maintenance performed as necessary.

D) Formal inspections will be made annually, by a qualified registered professional engineer or other qualified person under the direction of a professional engineer, including any reports or modifications, in accordance with 880-X- 10C- .20[1(j)] of the Alabama Surface Mining Regulations.

E) Retained sediment will be removed from each sediment basin when the accumulated sediment reaches the maximum allowable sediment volume as set forth in the detailed design plans.

## 4. BASIN REMOVAL REQUIREMENTS

A) Upon completion of mining, reclamation, restabilization and effluent standards being met, each sediment basin not proposed as a permanent water impoundment will be dewatered in a controlled manner by either pumping or siphoning. Upon successful dewatering, a determination will be made as to the retained sediment level in the basin. After determining the retained sediment level, a channel will be cut into the embankment down to the retained sediment level on the side of the embankment deemed most suitable to reach natural ground without encountering prohibiting rock. The embankment material removed from this newly constructed channel will be spread and compacted over the previous impoundment (wet area) area to prevent erosion and ensure restabilization. The newly constructed channel will be of adequate width (minimum 30 feet) and sloped to a grade (approximately 1% to 3%) which will cause all surface drainage to travel across this area in sheet flow, minimizing the possibility of erosion. Also, where necessary, hay dams will be installed in strategic locations across the width of the channel to retain sediment and slow the water velocity to a favorable rate. Upon removal of the embankment section, all disturbed areas will be graded in such a manner to ensure slope stability, successful restabilization and to minimize erosion. All disturbed areas will be seeded with a mixture of annual and perennial grasses, fertilized and mulched. No slope, existing or created in the removal of the sediment basin, will be left on a grade that will slip or slough.

## 5. PERMANENT WATER IMPOUNDMENT REQUIREMENTS

A) Prior to a request for a Phase II Bond Release, all sediment basins being left as permanent water impoundments will have supplemental data submitted to the Regulatory Authority concerning water quality, water quantity, size, depth, configuration, postmining land use, etc.

B) Final grading slopes of the entire permanent water impoundment area will not exceed a slope of 2 Horizontal to 1 Vertical to provide for safety and access for future water users.

# DETAILED DESIGN PLANS
# SEDIMENT BASIN 051

# Concord Prep Plant, P-3233. Sediment Basin 051

## Elevation-Area-Capacity Table

| Elevation (ft) | Area (ac) | Capacity (ac-ft) |
|---|---|---|
| 511.00 | 0.000 | 0.000 |
| 511.50 | 0.002 | 0.000 |
| 512.00 | 0.010 | 0.003 |
| 512.50 | 0.014 | 0.009 |
| 513.00 | 0.019 | 0.017 |
| 513.50 | 0.024 | 0.028 |
| 514.00 | 0.030 | 0.042 |
| 514.50 | 0.044 | 0.060 |
| 515.00 | 0.060 | 0.086 |
| 515.50 | 0.079 | 0.120 |
| 516.00 | 0.100 | 0.165 |
| 516.50 | 0.116 | 0.219 |
| 517.00 | 0.133 | 0.281 |
| 517.50 | 0.151 | 0.352 |
| 518.00 | 0.170 | 0.432 |
| 518.50 | 0.199 | 0.524 |
| 519.00 | 0.230 | 0.631 |
| 519.50 | 0.264 | 0.755 |
| 520.00 | 0.300 | 0.896 |
| 520.50 | 0.339 | 1.055 |
| 521.00 | 0.380 | 1.235 |
| 521.50 | 0.424 | 1.436 |
| 522.00 | 0.470 | 1.659 |
| 522.50 | 0.525 | 1.908 |
| 523.00 | 0.584 | 2.185 |
| 523.50 | 0.645 | 2.492 |
| 524.00 | 0.710 | 2.831 |
| 524.50 | 0.787 | 3.205 |
| 525.00 | 0.867 | 3.618 |
| 525.50 | 0.952 | 4.073 |
| 526.00 | 1.040 | 4.571 |
| 526.50 | 1.134 | 5.114 |
| 527.00 | 1.232 | 5.705 |
| 527.50 | 1.334 | 6.346 |
| 528.00 | 1.440 | 7.040 |
| 528.50 | 1.533 | 7.783 |
| 529.00 | 1.629 | 8.573 |

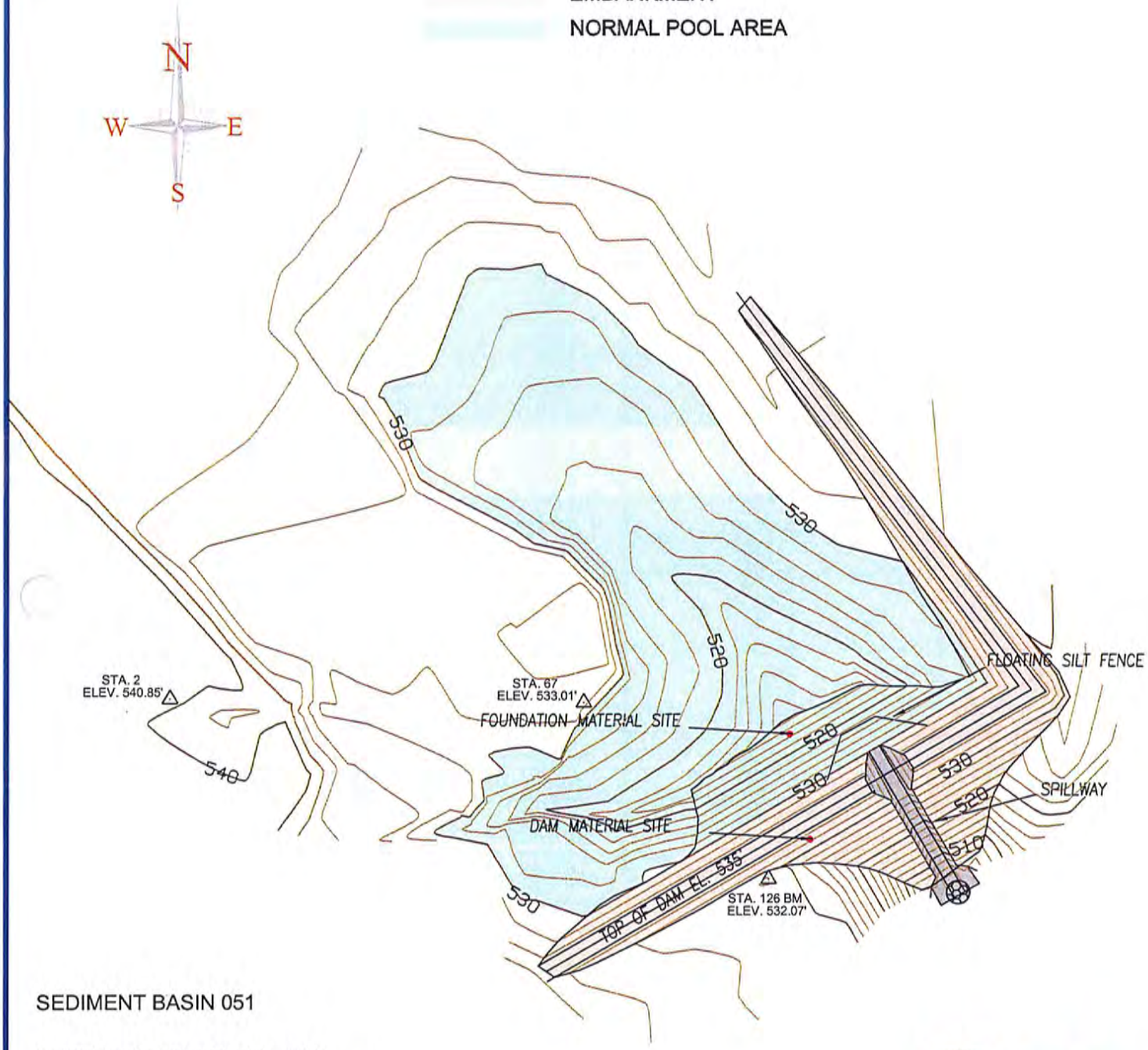
| Elevation (ft) | Area (ac) | Capacity (ac-ft) |
|---|---|---|
| 529.50 | 1.728 | 9.413 |
| 530.00 | 1.830 | 10.302 |
| 530.50 | 1.958 | 11.249 |
| 531.00 | 2.091 | 12.261 |
| 531.50 | 2.228 | 13.341 |
| 532.00 | 2.370 | 14.490 |
| 532.50 | 2.641 | 15.742 |
| 533.00 | 2.926 | 17.133 |
| 533.50 | 3.226 | 18.671 |
| 534.00 | 3.540 | 20.361 |

# OAK GROVE RESOURCES, LLC.
# CONCORD PREPARATION PLANT, P-3233

## PLAN VIEW DRAWING
SCALE: 1" = 100'

EMBANKMENT

NORMAL POOL AREA




SEDIMENT BASIN 051

UPSTREAM TOE ELEV.: 511'
SEDIMENT REMOVAL ELEV.: 528'
PRIMARY SPILLWAY ELEV.: 530'
**MAXIMUM WATER ELEV.: 532.35'
TOP OF DAM ELEV.: 533.35' DESIGN
TOP OF DAM ELEV.: 535' CONSTRUCT.

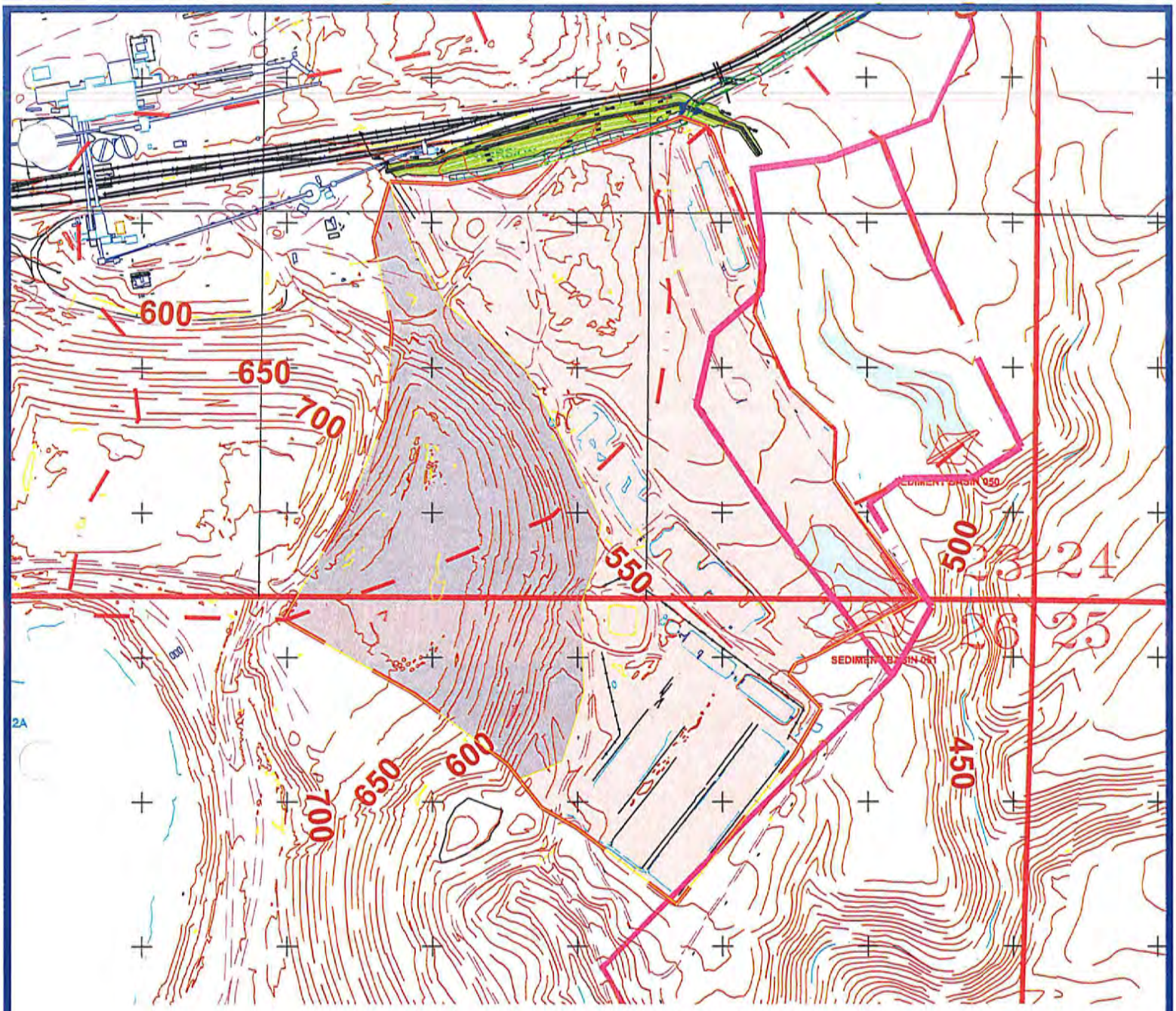
SPILLWAY: 8' WIDE TRAPEZOIDAL
CONCRETE LINED


mcgehee engineering corp
post office box 3431
jasper, alabama 35502-3431
telephone: (205) 221-0686 fax: 221-7721
email: cw@mcgehee.org


⊛ ENERGY DISSIPATER (CLASS II SANDSTONE RIPRAP)

** 25 YEAR - 6 HOUR PRECIPITATION EVENT.

Bobby Usher–Z:\Mining\BASEMAPS\Cleveland Cliffs\Concord\BASIN DESIGN\POND 051 PLAN VIEW.dwg – Jul 09, 2015 – 4:52pm




## MAP LEGEND

ASMC PERMIT BOUNDARY

WATERSHED BOUNDARY

SWS1 DISTURBED AREA CN 81

SWS2 COARSE REFUSE CN 81

B — SEDIMENT BASIN, C.N. 100

N
W E
S

mcgehee engineering corp
post office box 3431
jasper, alabama 35502-3431
telephone: (205) 221-0686 fax: 221-7721
email: staff@mcgehee.org

10 FOOT CONTOUR INTERVAL

CLIFFS

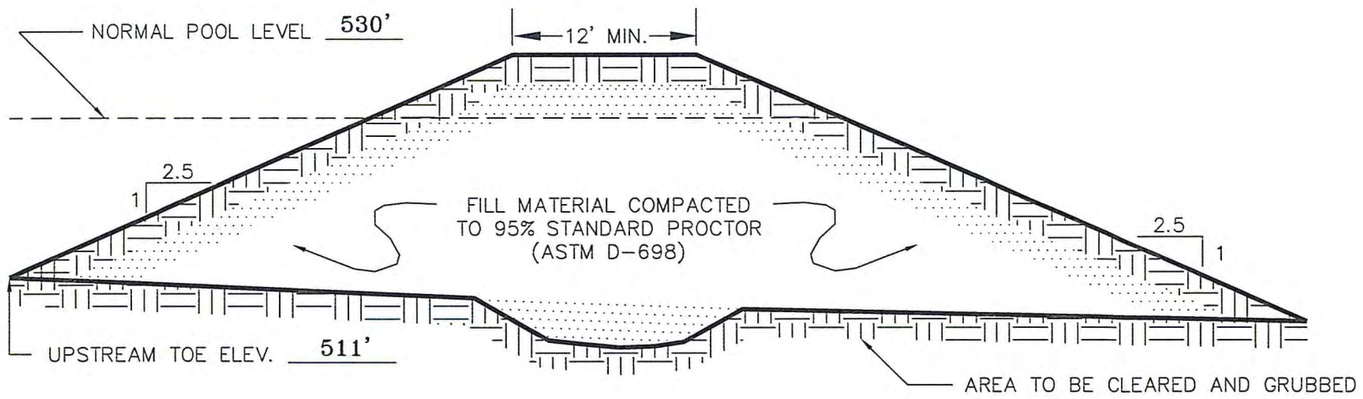
CONCORD PREP PLANT
REFUSE PILE

SEDIMENT BASIN 051
WATERSHED MAP

| FILE: | SCALE: 1"=500' | JOB NO.: |
|---|---|---|
| APPROVED BY: R.W.U. | DATE: 7/9/15 | SHEET NO.: 1 OF 1 |

Bobby Usher-Z:\Mining\BASEMAPS\Cleveland Cliffs\Concord\Proposed expansion\REVISED EXPANSION FILES ADDING 3A 4-16-15\REVISED Concord Refuse expansion SITE 3A ONLY 4-14-15.dwg - Jul 09, 2015 - 4

# EMBANKMENT CROSS-SECTION



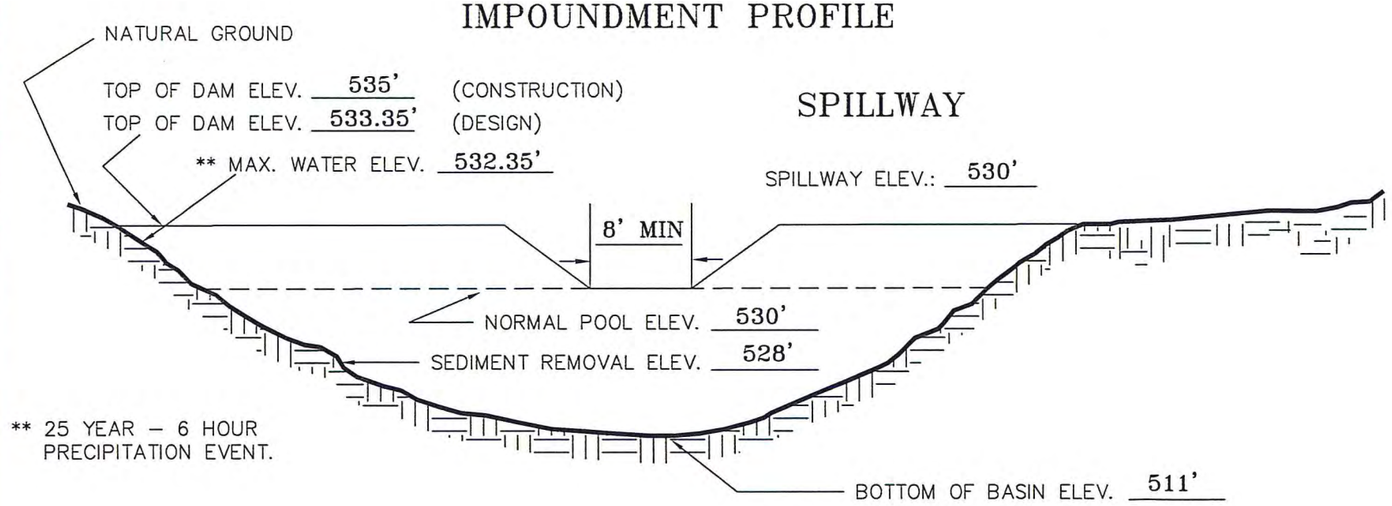

COMPANY: OAK GROVE RESOURCES, LLC

MINE NAME: CONCORD PREPARATION PLANT

PERMIT #: P-3233

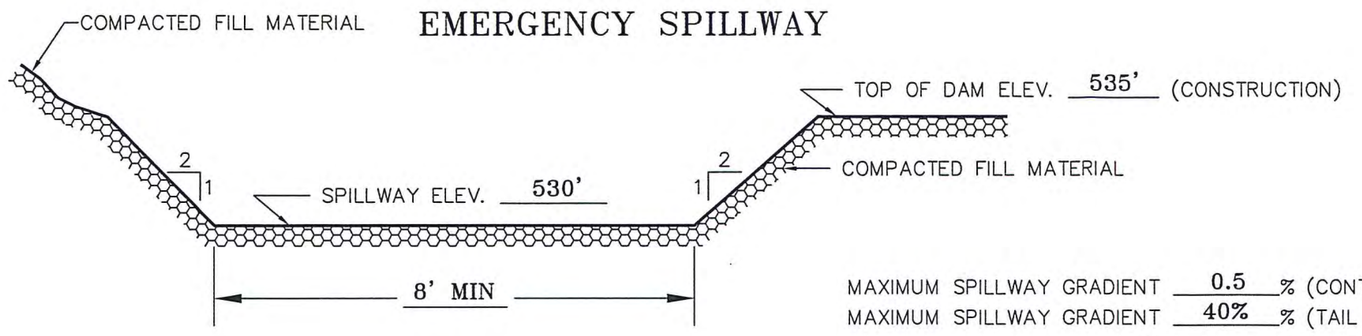
BASIN I.D. #: SEDIMENT BASIN 051

# IMPOUNDMENT PROFILE




## SPILLWAY

## EMERGENCY SPILLWAY




MAXIMUM SPILLWAY GRADIENT 0.5 % (CONTROL SECTION)

MAXIMUM SPILLWAY GRADIENT 40% % (TAIL DITCH SECTION)

SEE SPILLWAY CONTROL SECTION AND TAIL DITCH DESIGN FOR CHANNEL LINING REQUIREMENTS.

# KEY BASIN PARAMETERS

| | | |
|---|---|---|
| DRAINAGE AREA | 77.6 | ACRES |
| DISTURBED AREA | 77.6 | ACRES |
| SEDIMENT STORAGE | 7 | AC.FT. |
| DETENTION STORAGE | 3.30 | AC.FT. |
| PERMANENT POOL CAPACITY | 10.3 | AC.FT. |
| * TOTAL BASIN STORAGE CAPACITY | 14.48 | AC.FT. |
| ** PEAK INFLOW | 173.99 | C.F.S. |
| ** PEAK OUTFLOW | 107.81 | C.F.S. |

NOTE: ALL ELEVATIONS ASSUMED.

* 10 YEAR - 24 HOUR PRECIPITATION EVENT.

** 25 YEAR - 6 HOUR PRECIPITATION EVENT.

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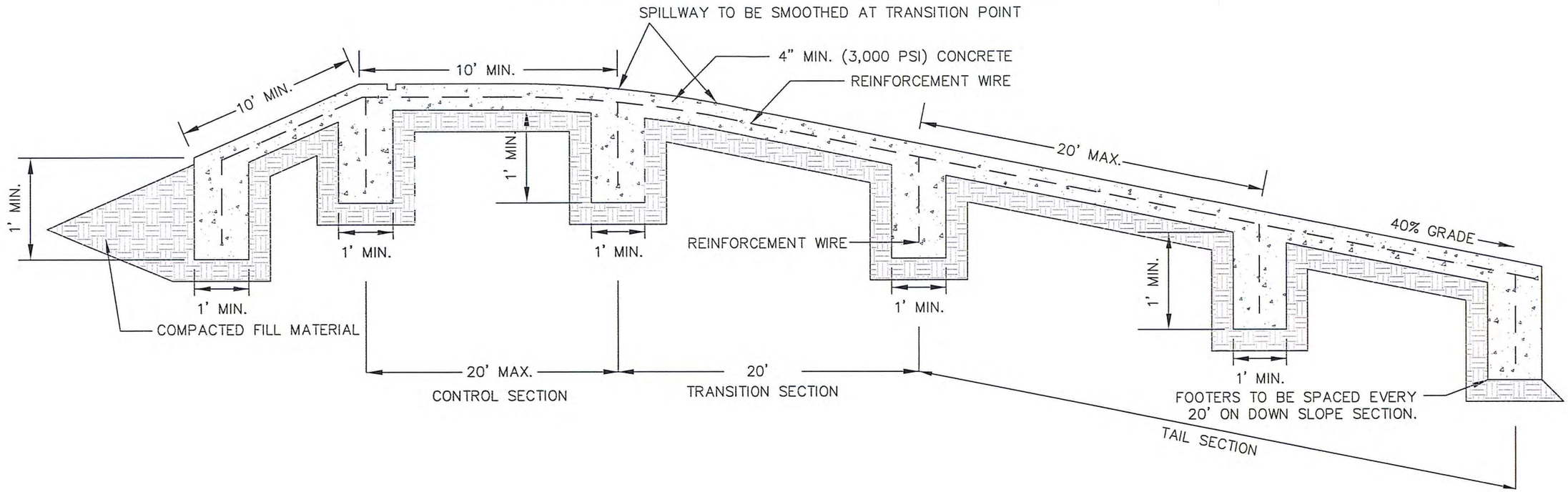
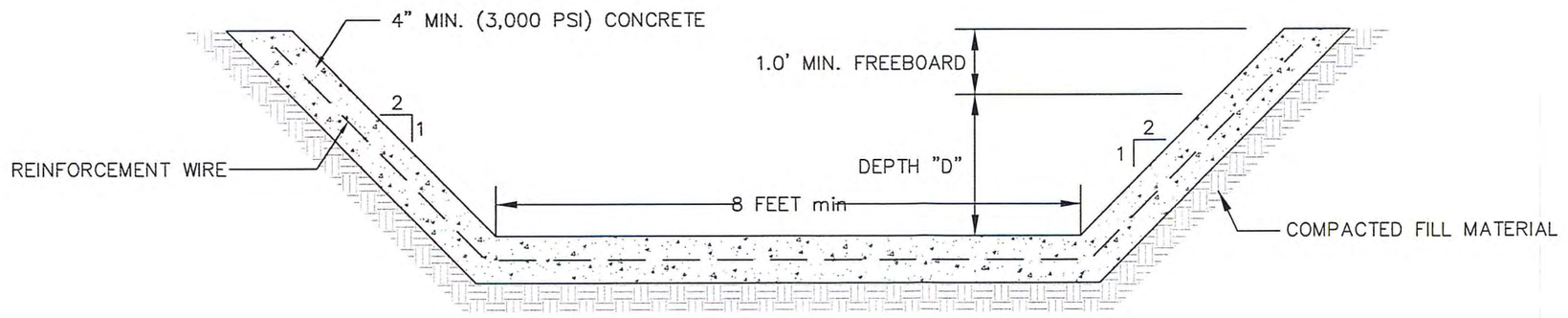
email: cw@mcgehee.org

# SEDIMENT BASIN 051 SPILLWAY PROFILE




# TYPICAL SPILLWAY CROSS-SECTION




SPILLWAY FLOW DEPTH "D" = 2.35 FEET (CONTROL SECTION)

SPILLWAY FLOW DEPTH "D" = 0.49 FEET (TAIL DITCH SECTION)

TOTAL SPILLWAY DEPTH "D+1" = 3.35 FEET (CONTROL SECTION)

TOTAL SPILLWAY DEPTH "D+1" = 1.49 FEET (TAIL DITCH SECTION)

NOTE: TOTAL SPILLWAY DEPTH IN TRANSITION SECTION VARIES FROM 3.35 FEET TO 1.49FEET

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## SPILLWAY CHANNEL SPECIFICATIONS
## SEDIMENT BASIN 051

The entire control section and tail ditch section of the emergency spillway will be cut into the compacted fill of the embankment and lined with a minimum of 4 inches of reinforced concrete. All concrete will be reinforced with 10 gauge, 6" x 6" welded wire mesh. Fibermesh may be added to the concrete for additional strength, however, the addition of fibermesh shall not be used in place of the required 6" x 6" welded wire.

The gradient of the control section of the emergency spillway will not exceed two (2%) percent. The gradient of the tail ditch section of the emergency spillway will not exceed forty (40%) percent.

The control section and tail ditch section of the emergency spillway will extend from the inner face of the embankment, past the centerline of the embankment and be carried out beyond the downstream slope of the embankment.

The concrete liner of the control section of the emergency spillway will be a minimum of 3.35 as measured vertically, allowing 2.35 feet for the maximum anticipated flow and 1.0 feet of dry freeboard. The concrete liner of the tail ditch section of the emergency spillway will be a minimum of 1.49 feet as measured vertically, allowing 0.49 feet for the maximum anticipated flow and 1.0 foot of dry freeboard. There will be a transition zone of at least 20 feet in length between the control section and the tail section. The minimum depth at the beginning of the transition will be 3.35 feet and 1.1.49 feet at the end of the transition. The flow line of the spillway will be smoothed at the transition to avoid abrupt changes in the flow line slope.

See enclosed SEDCAD 4.0 spillway tail ditch section design and attached Plan Sheet cross-section for the minimum and maximum emergency spillway construction requirements.

A floating silt fence (lightweight turbidity curtain) will be installed near the entrance to the spillway to accomplish sub-surface withdrawal. The floating silt fence (lightweight turbidity curtain) will be set at normal pool and will be anchored at the 10 Year – 24 Hour Event peak stage with steel fence posts.

# Concord Prep Plant, Basin 051 Spillway Control Section

Material: Concrete, Rubble

*Trapezoidal Channel*

| Bottom Width (ft) | Left Sideslope Ratio | Right Sideslope Ratio | Slope (%) | Manning's n | Freeboard Depth (ft) | Freeboard % of Depth | Freeboard Mult. x (VxD) |
|---|---|---|---|---|---|---|---|
| 8.00 | 2.0:1 | 2.0:1 | 2.0 | 0.0220 | 1.00 | | |

| | w/o Freeboard | w/ Freeboard |
|---|---|---|
| Design Discharge: | 107.81 cfs | |
| Depth: | 1.16 ft | 2.16 ft |
| Top Width: | 12.65 ft | 16.65 ft |
| Velocity: | 8.99 fps | |
| X-Section Area: | 12.00 sq ft | |
| Hydraulic Radius: | 0.909 ft | |
| Froude Number: | 1.63 | |

# Concord Prep Plant, Basin 051 Spillway Tail Ditch Section

Material: Concrete, Rubble

*Trapezoidal Channel*

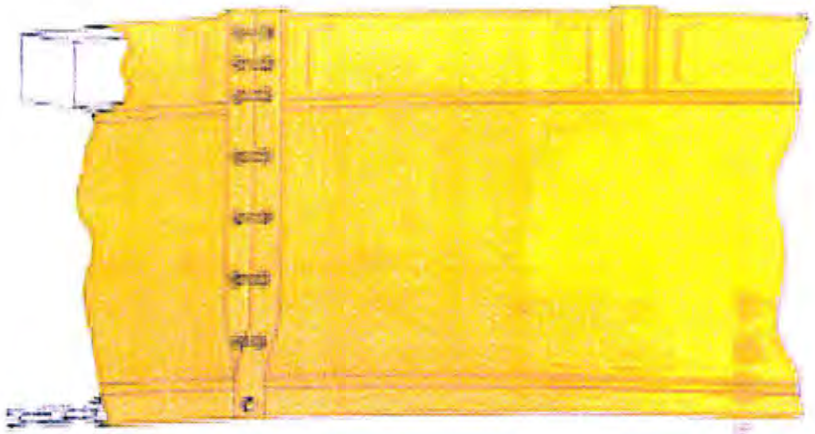
| Bottom Width (ft) | Left Sideslope Ratio | Right Sideslope Ratio | Slope (%) | Manning's n | Freeboard Depth (ft) | Freeboard % of Depth | Freeboard Mult. x (VxD) |
|---|---|---|---|---|---|---|---|
| 8.00 | 2.0:1 | 2.0:1 | 40.0 | 0.0220 | 1.00 | | |

| | w/o Freeboard | w/ Freeboard |
|---|---|---|
| Design Discharge: | 107.81 cfs | |
| Depth: | 0.49 ft | 1.49 ft |
| Top Width: | 9.96 ft | 13.96 ft |
| Velocity: | 24.48 fps | |
| X-Section Area: | 4.40 sq ft | |
| Hydraulic Radius: | 0.432 ft | |
| Froude Number: | 6.49 | |

# SUBSURFACE WITHDRAWAL DEVICE AND FLOATING SILT BOOM

**Lightweight Turbidity Curtain**

Application: Calm waters with little current, such as lakes, ponds, canals and shoreline areas.



## Specifications

- Curtain to be anchored at the maximum anticipated peak stage elevation (10 Year – 24 Hour Precipitation Event).
- PVC coated floatations - ultraviolet resistant
- Geotextile fabric screens
- Chain ballast with connectors
- Double sewn seams with grommets
- Depths per requirements ' 50' sections = Minimum 24" deep
- Fabric - Polyester reinforced vinyl high visibility yellow
- Connector - Sections are laced together through grommets and load lines are bolted together.
- Flotation - 6" expanded polystyrene over 9 lbs./ft. buoyancy.
- Ballast - 1/4" galvanized chain (.7 lbs/ft).

# HYDROLOGY AND SEDIMENTOLOGY PREDICTION
# 10 YEAR - 24 HOUR PRECIPITATION EVENT
# SEDIMENT BASIN 051

# Oak Grove Resources, LLC.
# Concord Preparation Plant
# Sediment Basin 051

***10 year, 24 hour event***

Robert W. Usher, P.E.

# General Information

## Storm Information:

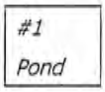
| | |
|---|---|
| Storm Type: | DRN 58 |
| Design Storm: | 10 yr - 24 hr |
| Rainfall Depth: | 6.000 inches |

## Particle Size Distribution:

| Size (mm) | cover soil | refuse |
|---|---|---|
| 4.7500 | 100.000% | 100.000% |
| 3.0000 | 78.000% | 47.870% |
| 2.0000 | 63.000% | 29.130% |
| 1.0000 | 47.000% | 12.170% |
| 0.5000 | 30.500% | 5.300% |
| 0.3000 | 19.900% | 3.300% |
| 0.2000 | 14.300% | 1.800% |
| 0.1000 | 7.400% | 0.830% |
| 0.0500 | 5.000% | 0.300% |
| 0.0300 | 3.700% | 0.200% |
| 0.0200 | 1.900% | 0.100% |
| 0.0100 | 0.800% | 0.050% |
| 0.0050 | 0.350% | 0.000% |
| 0.0030 | 0.270% | 0.000% |
| 0.0010 | 0.190% | 0.000% |
| 0.0000 | 0.000% | 0.000% |

# *Structure Networking:*

| Type | Stru # | (flows into) | Stru # | Musk. K (hrs) | Musk. X | Description |
|---|---|---|---|---|---|---|
| Pond | #1 | ==> | End | 0.000 | 0.000 | Basin 051 |



# *Structure Summary:*

| | | Immediate Contributing Area (ac) | Total Contributing Area (ac) | Peak Discharge (cfs) | Total Runoff Volume (ac-ft) | Sediment (tons) | Peak Sediment Conc. (mg/l) | Peak Settleable Conc. (ml/l) | 24VW (ml/l) |
|---|---|---|---|---|---|---|---|---|---|
| #1 | In | 77.600 | 77.600 | 91.52 | 23.69 | 4,168.0 | 209,895 | 165.99 | 96.22 |
| | Out | | | 77.69 | 23.65 | 33.5 | 2,322 | 0.11 | 0.06 |

# *Particle Size Distribution(s) at Each Structure*

## *Structure #1:*

| Size (mm) | In | Out |
|---|---|---|
| 4.7500 | 100.000% | 100.000% |
| 3.0000 | 82.219% | 100.000% |
| 2.0000 | 66.407% | 100.000% |
| 1.0000 | 49.542% | 100.000% |
| 0.5000 | 32.150% | 100.000% |
| 0.3000 | 20.976% | 100.000% |
| 0.2000 | 15.073% | 100.000% |
| 0.1000 | 7.800% | 100.000% |
| 0.0500 | 5.270% | 100.000% |
| 0.0300 | 3.900% | 100.000% |
| 0.0200 | 2.003% | 100.000% |
| 0.0100 | 0.843% | 100.000% |
| 0.0050 | 0.369% | 45.870% |
| 0.0030 | 0.285% | 35.386% |
| 0.0010 | 0.200% | 24.901% |
| 0.0000 | 0.000% | 0.000% |

# *Structure Detail:*

*Structure #1 (Pond)*

*Basin 051*

Pond Inputs:

| | |
|---|---|
| Initial Pool Elev: | 530.00 ft |
| Initial Pool: | 3.30 ac-ft |
| *Sediment Storage: | 7.00 ac-ft |
| Dead Space: | 20.00 % |

**Sediment capacity was entered by user*

## Emergency Spillway

| Spillway Elev | Crest Length (ft) | Left Sideslope | Right Sideslope | Bottom Width (ft) |
|---|---|---|---|---|
| 530.00 | 20.00 | 2.00:1 | 2.00:1 | 8.00 |

Pond Results:

| | |
|---|---|
| Peak Elevation: | 531.99 ft |
| H'graph Detention Time: | 1.47 hrs |
| Pond Model: | CSTRS |
| Dewater Time: | 0.85 days |
| Trap Efficiency: | 99.20 % |

*Dewatering time is calculated from peak stage to lowest spillway*

## Elevation-Capacity-Discharge Table

| Elevation | Area (ac) | Capacity (ac-ft) | Discharge (cfs) | Dewater Time (hrs) | |
|---|---|---|---|---|---|
| 527.97 | 1.434 | 0.000 | 0.000 | | Top of Sed. Storage |
| 528.00 | 1.440 | 0.041 | 0.000 | | |
| 528.50 | 1.533 | 0.784 | 0.000 | | |
| 528.80 | 1.591 | 1.253 | 0.000 | | |
| 529.00 | 1.630 | 1.575 | 0.000 | | |
| 529.50 | 1.728 | 2.414 | 0.000 | | |
| 530.00 | 1.830 | 3.304 | 0.000 | | Spillway #1 |
| 530.50 | 1.958 | 4.251 | 1.472 | 7.79* | |
| 531.00 | 2.091 | 5.263 | 20.905 | 10.65 | |
| 531.50 | 2.228 | 6.343 | 44.784 | 1.30 | |
| 531.99 | 2.368 | 7.474 | 77.690 | 0.70 | Peak Stage |
| 532.00 | 2.370 | 7.492 | 78.212 | | |

| Elevation | Area (ac) | Capacity (ac-ft) | Discharge (cfs) | Dewater Time (hrs) |
|---|---|---|---|---|
| 532.50 | 2.641 | 8.744 | 120.617 | |
| 533.00 | 2.926 | 10.135 | 172.366 | |
| 533.50 | 3.226 | 11.672 | 233.863 | |
| 534.00 | 3.540 | 13.363 | 305.523 | |

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

## Detailed Discharge Table

| Elevation (ft) | Emergency Spillway (cfs) | Combined Total Discharge (cfs) |
|---|---|---|
| 527.97 | 0.000 | 0.000 |
| 528.00 | 0.000 | 0.000 |
| 528.50 | 0.000 | 0.000 |
| 528.80 | 0.000 | 0.000 |
| 529.00 | 0.000 | 0.000 |
| 529.50 | 0.000 | 0.000 |
| 530.00 | 0.000 | 0.000 |
| 530.50 | 1.472 | 1.472 |
| 531.00 | 20.905 | 20.905 |
| 531.50 | 44.784 | 44.784 |
| 532.00 | 78.212 | 78.212 |
| 532.50 | 120.617 | 120.617 |
| 533.00 | 172.366 | 172.366 |
| 533.50 | 233.863 | 233.863 |
| 534.00 | 305.523 | 305.523 |

## Subwatershed Hydrology Detail:

| Stru # | SWS # | SWS Area (ac) | Time of Conc (hrs) | Musk K (hrs) | Musk X | Curve Number | UHS | Peak Discharge (cfs) | Runoff Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| #1 | 1 | 52.300 | 0.360 | 0.000 | 0.000 | 81.000 | F | 61.59 | 15.955 |
| | 2 | 25.300 | 0.310 | 0.000 | 0.000 | 81.000 | F | 29.96 | 7.736 |
| | Σ | **77.600** | | | | | | **91.52** | **23.691** |

## Subwatershed Sedimentology Detail:

| Stru # | SWS # | Soil K | L (ft) | S (%) | C | P | PS # | Sediment (tons) | Peak Sediment Conc. (mg/l) | Peak Settleable Conc (ml/l) | 24VW (ml/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | 1 | 0.320 | 200.00 | 7.00 | 0.9000 | 1.0000 | 1 | 1,613.7 | 125,021 | 98.87 | 56.74 |
| | 2 | 0.320 | 200.00 | 17.00 | 0.9000 | 1.0000 | 1 | 2,554.4 | 366,108 | 289.53 | 171.80 |
| | Σ | | | | | | | **4,168.0** | **209,895** | **165.99** | **96.22** |

## Subwatershed Time of Concentration Details:

| Stru # | SWS # | Land Flow Condition | Slope (%) | Vert. Dist. (ft) | Horiz. Dist. (ft) | Velocity (fps) | Time (hrs) |
|---|---|---|---|---|---|---|---|
| #1 | 1 | 8. Large gullies, diversions, and low flowing streams | 2.14 | 30.00 | 1,400.00 | 4.390 | 0.088 |
| **#1** | **1** | **Time of Concentration:** | | | | | **0.360** |

# HYDROLOGY AND SEDIMENTOLOGY PREDICTION
# 25 YEAR - 6 HOUR PRECIPITATION EVENT
# SEDIMENT BASIN 051

# Oak Grove Resources, LLC.
# Concord Preparation Plant
# Sediment Basin 051

***25 year, 6 hour event***

Robert W. Usher, P.E.

# General Information

## Storm Information:

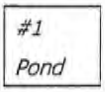
| | |
|---|---|
| Storm Type: | SCS 6 HOUR |
| Design Storm: | 25 yr - 6 hr |
| Rainfall Depth: | 5.000 inches |

## Particle Size Distribution:

| Size (mm) | cover soil | refuse |
|---|---|---|
| 4.7500 | 100.000% | 100.000% |
| 3.0000 | 78.000% | 47.870% |
| 2.0000 | 63.000% | 29.130% |
| 1.0000 | 47.000% | 12.170% |
| 0.5000 | 30.500% | 5.300% |
| 0.3000 | 19.900% | 3.300% |
| 0.2000 | 14.300% | 1.800% |
| 0.1000 | 7.400% | 0.830% |
| 0.0500 | 5.000% | 0.300% |
| 0.0300 | 3.700% | 0.200% |
| 0.0200 | 1.900% | 0.100% |
| 0.0100 | 0.800% | 0.050% |
| 0.0050 | 0.350% | 0.000% |
| 0.0030 | 0.270% | 0.000% |
| 0.0010 | 0.190% | 0.000% |
| 0.0000 | 0.000% | 0.000% |

# *Structure Networking:*

| Type | Stru # | (flows into) | Stru # | Musk. K (hrs) | Musk. X | Description |
|---|---|---|---|---|---|---|
| Pond | #1 | ==> | End | 0.000 | 0.000 | Basin 051 |



# *Structure Summary:*

| | | Immediate Contributing Area (ac) | Total Contributing Area (ac) | Peak Discharge (cfs) | Total Runoff Volume (ac-ft) | Sediment (tons) | Peak Sediment Conc. (mg/l) | Peak Settleable Conc. (ml/l) | 24VW (ml/l) |
|---|---|---|---|---|---|---|---|---|---|
| #1 | In | 77.600 | 77.600 | 173.99 | 18.21 | 5,184.3 | 286,011 | 225.90 | 151.16 |
| | Out | | | 107.81 | 18.21 | 59.9 | 4,337 | 0.76 | 0.43 |

# *Particle Size Distribution(s) at Each Structure*

## *Structure #1:*

| Size (mm) | In | Out |
|---|---|---|
| 4.7500 | 100.000% | 100.000% |
| 3.0000 | 90.987% | 100.000% |
| 2.0000 | 73.490% | 100.000% |
| 1.0000 | 54.826% | 100.000% |
| 0.5000 | 35.578% | 100.000% |
| 0.3000 | 23.213% | 100.000% |
| 0.2000 | 16.681% | 100.000% |
| 0.1000 | 8.632% | 100.000% |
| 0.0500 | 5.833% | 100.000% |
| 0.0300 | 4.316% | 100.000% |
| 0.0200 | 2.216% | 100.000% |
| 0.0100 | 0.933% | 80.833% |
| 0.0050 | 0.408% | 35.365% |
| 0.0030 | 0.315% | 27.281% |
| 0.0010 | 0.222% | 19.198% |
| 0.0000 | 0.000% | 0.000% |

# *Structure Detail:*

*Structure #1 (Pond)*

*Basin 051*

Pond Inputs:

| | |
|---|---|
| Initial Pool Elev: | 530.00 ft |
| Initial Pool: | 3.30 ac-ft |
| *Sediment Storage: | 7.00 ac-ft |
| Dead Space: | 20.00 % |

**Sediment capacity was entered by user*

## Emergency Spillway

| Spillway Elev | Crest Length (ft) | Left Sideslope | Right Sideslope | Bottom Width (ft) |
|---|---|---|---|---|
| 530.00 | 20.00 | 2.00:1 | 2.00:1 | 8.00 |

Pond Results:

| | |
|---|---|
| Peak Elevation: | 532.35 ft |
| H'graph Detention Time: | 1.18 hrs |
| Pond Model: | CSTRS |
| Dewater Time: | 0.52 days |
| Trap Efficiency: | 98.85 % |

*Dewatering time is calculated from peak stage to lowest spillway*

## Elevation-Capacity-Discharge Table

| Elevation | Area (ac) | Capacity (ac-ft) | Discharge (cfs) | Dewater Time (hrs) | |
|---|---|---|---|---|---|
| 527.97 | 1.434 | 0.000 | 0.000 | | Top of Sed. Storage |
| 528.00 | 1.440 | 0.041 | 0.000 | | |
| 528.50 | 1.533 | 0.784 | 0.000 | | |
| 528.80 | 1.591 | 1.253 | 0.000 | | |
| 529.00 | 1.630 | 1.575 | 0.000 | | |
| 529.50 | 1.728 | 2.414 | 0.000 | | |
| 530.00 | 1.830 | 3.304 | 0.000 | | Spillway #1 |
| 530.50 | 1.958 | 4.251 | 1.472 | 7.79* | |
| 531.00 | 2.091 | 5.263 | 20.905 | 1.70 | |
| 531.50 | 2.228 | 6.343 | 44.784 | 1.70 | |
| 532.00 | 2.370 | 7.492 | 78.212 | 0.90 | |
| 532.35 | 2.578 | 8.366 | 107.809 | 0.50 | Peak Stage |

| Elevation | Area (ac) | Capacity (ac-ft) | Discharge (cfs) | Dewater Time (hrs) |
|---|---|---|---|---|
| 532.50 | 2.641 | 8.744 | 120.617 | |
| 533.00 | 2.926 | 10.135 | 172.366 | |
| 533.50 | 3.226 | 11.672 | 233.863 | |
| 534.00 | 3.540 | 13.363 | 305.523 | |

**Designates time(s) to dewater have been extrapolated beyond the 50 hour hydrograph limit.*

## Detailed Discharge Table

| Elevation (ft) | Emergency Spillway (cfs) | Combined Total Discharge (cfs) |
|---|---|---|
| 527.97 | 0.000 | 0.000 |
| 528.00 | 0.000 | 0.000 |
| 528.50 | 0.000 | 0.000 |
| 528.80 | 0.000 | 0.000 |
| 529.00 | 0.000 | 0.000 |
| 529.50 | 0.000 | 0.000 |
| 530.00 | 0.000 | 0.000 |
| 530.50 | 1.472 | 1.472 |
| 531.00 | 20.905 | 20.905 |
| 531.50 | 44.784 | 44.784 |
| 532.00 | 78.212 | 78.212 |
| 532.50 | 120.617 | 120.617 |
| 533.00 | 172.366 | 172.366 |
| 533.50 | 233.863 | 233.863 |
| 534.00 | 305.523 | 305.523 |

## Subwatershed Hydrology Detail:

| Stru # | SWS # | SWS Area (ac) | Time of Conc (hrs) | Musk K (hrs) | Musk X | Curve Number | UHS | Peak Discharge (cfs) | Runoff Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| #1 | 1 | 52.300 | 0.360 | 0.000 | 0.000 | 81.000 | F | 115.82 | 12.264 |
| | 2 | 25.300 | 0.310 | 0.000 | 0.000 | 81.000 | F | 58.32 | 5.947 |
| | Σ | **77.600** | | | | | | **173.99** | **18.211** |

## Subwatershed Sedimentology Detail:

| Stru # | SWS # | Soil K | L (ft) | S (%) | C | P | PS # | Sediment (tons) | Peak Sediment Conc. (mg/l) | Peak Settleable Conc (ml/l) | 24VW (ml/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| #1 | 1 | 0.320 | 200.00 | 7.00 | 0.9000 | 1.0000 | 1 | 1,983.4 | 168,167 | 132.80 | 89.16 |
| | 2 | 0.320 | 200.00 | 17.00 | 0.9000 | 1.0000 | 1 | 3,200.8 | 487,518 | 385.10 | 265.89 |
| | Σ | | | | | | | **5,184.3** | **286,011** | **225.90** | **151.16** |

## Subwatershed Time of Concentration Details:

| Stru # | SWS # | Land Flow Condition | Slope (%) | Vert. Dist. (ft) | Horiz. Dist. (ft) | Velocity (fps) | Time (hrs) |
|---|---|---|---|---|---|---|---|
| #1 | 1 | 8. Large gullies, diversions, and low flowing streams | 2.14 | 30.00 | 1,400.00 | 4.390 | 0.088 |
| **#1** | **1** | **Time of Concentration:** | | | | | **0.360** |

# STABILITY ANALYSIS

## STABILITY ANALYSIS PROCEDURE

The computer program used to analyze the slope stability was the REAME Slope Stability Program as developed by Dr. Yang H. Huang, P.E. of the University of Kentucky.

The soil type of the foundation material beneath the proposed embankment structure of Sediment Basin 051 was sampled, analyzed and classified by personnel of McGehee Engineering Corp. The depth to the stiff base of Sediment Basin 051 (1.7') was measured by personnel of McGehee Engineering Corp.

The soil type to be used in the construction of the proposed embankment structure of Sediment Basins 051 was sampled, analyzed and classified by personnel of McGehee Engineering Corp. This sample of material was taken from adjacent ridge top material that is representative of the material to be used as dam material.

## SOIL PROPERTIES

| USAGE | TYPE | COHESION (psf) | INTERNAL ANGLE OF FRICTION | EFFECTIVE DENSITY (pcf) |
|---|---|---|---|---|
| 051 FOUND. | SM | 270.00 | 33.02 | 132.14 |
| 051 DAM | SM-SC | 270.00 | 33.02 | 132.14 |

## ANALYSIS RESULTS

| BASIN | STATIC SAFETY FACTOR |
|---|---|
| 051 | 1.95 |

# SIEVE ANALYSIS

(ASTM C136-96a)

**Company Name:** Cliffs Natural Resources
**Location:** Concord
**Sample I.D.:** Basin 051
**Description:** Dam Material

**Sample Date:** 5/12/11
**Analyzed By:** JW
**Date Analyzed:** 5/31/11
**Requested By:** R. Usher

**Weight of Oven Dry Sample (W):** **1016.0 Grams**

| Sieve No. | Sieve + Sample Weight | Sieve Weight | Sample Weight Retained | Percent of Total Retained | Cumulative Weight Percent | Percent Retained | Percent Finer |
|---|---|---|---|---|---|---|---|
| 1" | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 3/4" | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 1/2" | 550.0 | 540.0 | 10.0 | 1.0 | 1.0 | 1.0 | 99.0 |
| 4 | 656.0 | 513.0 | 143.0 | 14.1 | 15.1 | 15.1 | 84.9 |
| 10 | 600.0 | 462.0 | 138.0 | 13.6 | 28.6 | 28.6 | 71.4 |
| 40 | 688.0 | 383.0 | 305.0 | 30.0 | 58.7 | 58.7 | 41.3 |
| 200 | 585.9 | 333.0 | 252.9 | 24.9 | 83.6 | 83.6 | 16.4 |
| Pan | 547.1 | 380.0 | 167.1 | 16.4 | 100.0 | 100.0 | 0.0 |
| | | Total Weight (W1): | 1016.0 | | | | |

# SOIL CLASSIFICATION

Unified System (ASTM D-2487)

**Liquid Limit:** 23.1
**Plastic Limit:** 20.9
**Plasticity Index:** 2.2

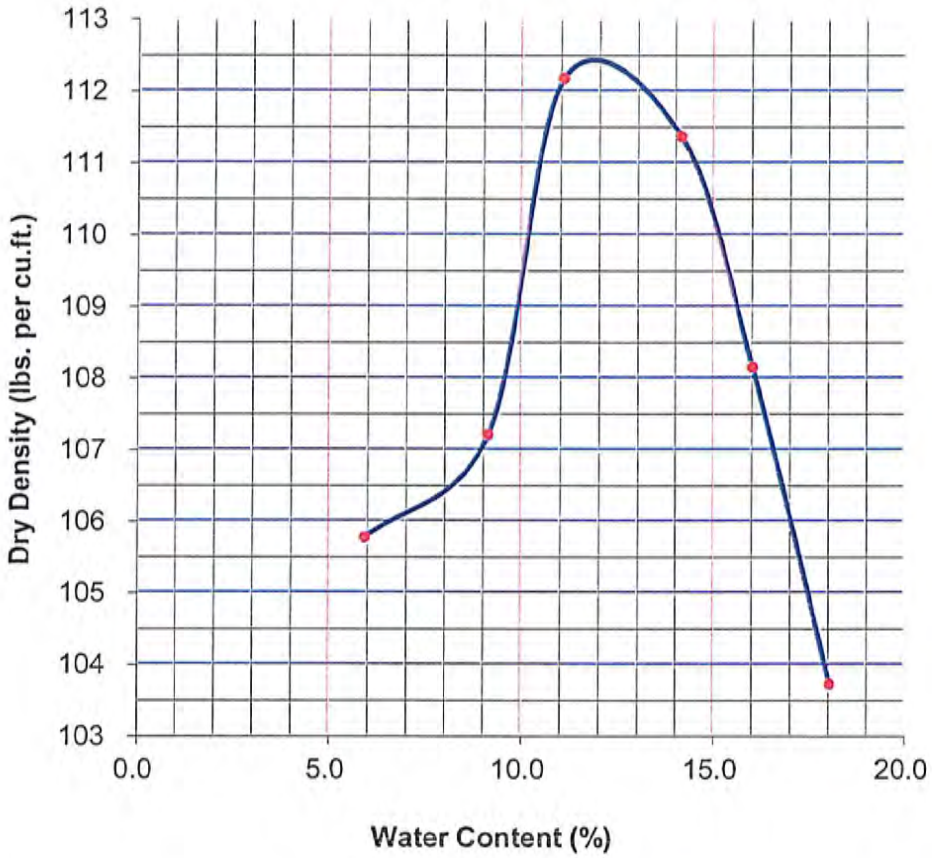
**Soil Classification:** SM

Coarse Grained
Silty Sand

**Effective Cohesion:** 1.8750 psi
**Total Cohesion:** 6.528 psi
**Permeability:** 12.30 ft/yr
**Maximum Dry Density:** 115.0 pcf
**Optimum Moisture:** 14.9 %
**Effective Cohesion:** 270.0 psf
**Angle of Internal Friction:** 33.02 degrees
**Mass Unit Weight:** 132.14 pcf

mcgehee engineering corp

Cliffs Natural Resources
Concord, Basin 051, Dam Material
Moisture Density Relationship
(Proctor Method)




| ASTM D-698 Method C | Water Content % | Specific Gravity | %> No. 4 | %< No. 200 | LL % | PL % | PI % |
|---|---|---|---|---|---|---|---|
| | | | 15.10 | 16.40 | 23.1 | 20.9 | 2.2 |

| Sample Description, Classification and Location | Sample No.: Basin 051 Dam Material |
|---|---|
| **Coarse Grained Silty Sand** | Optimum Moisture Content= 12.0<br>Maximum Dry Density = 112.4 |

# SIEVE ANALYSIS

(ASTM C136-96a)

**Company Name:** Cliffs Natural Resources
**Location:** Concord
**Sample I.D.:** Basin 051
**Description:** Foundation

**Sample Date:** 5/12/11
**Analyzed By:** JW
**Date Analyzed:** 5/31/11
**Requested By:** R. Usher

**Weight of Oven Dry Sample (W):** **1015.0 Grams**

| Sieve No. | Sieve + Sample Weight | Sieve Weight | Sample Weight Retained | Percent of Total Retained | Cumulative Weight Percent | Percent Retained | Percent Finer |
|---|---|---|---|---|---|---|---|
| 1" | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 3/4" | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 1/2" | 552.0 | 540.0 | 12.0 | 1.2 | 1.2 | 1.2 | 98.8 |
| 4 | 628.0 | 513.0 | 115.0 | 11.3 | 12.5 | 12.5 | 87.5 |
| 10 | 616.0 | 462.0 | 154.0 | 15.2 | 27.7 | 27.7 | 72.3 |
| 40 | 658.0 | 383.0 | 275.0 | 27.1 | 54.8 | 54.8 | 45.2 |
| 200 | 1033.1 | 771.0 | 262.1 | 25.8 | 80.6 | 80.6 | 19.4 |
| Pan | 576.9 | 380.0 | 196.9 | 19.4 | 100.0 | 100.0 | 0.0 |
| | **Total Weight (W1):** | | 1015.0 | | | | |

# SOIL CLASSIFICATION

Unified System (ASTM D-2487)

**Liquid Limit:** 24.2
**Plastic Limit:** 20.5
**Plasticity Index:** 3.7

**Soil Classification:** SM

Coarse Grained
Silty Sand

**Effective Cohesion:** 1.8750 psi
**Total Cohesion:** 6.528 psi
**Permeability:** 12.30 ft/yr
**Maximum Dry Density:** 115.0 pcf
**Optimum Moisture:** 14.9 %
**Effective Cohesion:** 270.0 psf
**Angle of Internal Friction:** 33.02 degrees
**Mass Unit Weight:** 132.14 pcf

# STABILITY ANALYSIS - COMPUTER OUTPUT
# SEDIMENT BASIN 051 - STATIC

# REAME
## (Rotational Equilibrium Analysis of Multilayered Embankments)

## Oak Grove Resources, LLC
## Concord Preparation Plant, P-3233
## Sediment Basin 051
## Static Case

OAK GROVE RESOURCES, LLC CONCORD PREP PLAN BASIN 051

Number of cases to be analyzed 1

Case Number 1

Number of boundary lines= 4
Number of points on boundary lines are: 2 2 3 7

On boundary line no. 1 Point no. and coordinates are:
1 .000 25.000 2 500.000 .000

On boundary line no. 2 Point no. and coordinates are:
1 200.000 17.000 2 350.857 9.457

On boundary line no. 3 Point no. and coordinates are:
1 .000 27.000 2 200.000 17.000 3 247.500 36.000

On boundary line no. 4 Point no. and coordinates are:
1 .000 36.000 2 247.500 36.000 3 260.000 41.000 4 272.000 41.000 5 335.595 15.562
6 350.857 9.457 7 500.000 2.000

Line no. and slope of each segment are:
1 -.050
2 -.050
3 -.050 .400
4 .000 .400 .000 -.400 -.400 -.050

No. of radius control zones= 1 Plot or no plot= 1 No. of seepage cases= 1

Total no. of lines at bottom of radius control zones is: 1

For rad. cont. zone no. 1 Radius decrement= .000 No. of Circles= 5 Id no. for first circle=, 1
Line no.= 1 Begin pt. no.= 1 End pt. no.= 2

| Soil no. | Cohesion | F. angle | Unit wt. |
|---|---|---|---|
| 1 | 270.000 | 33.020 | 132.140 |
| 2 | 270.000 | 33.020 | 132.140 |
| 3 | .000 | .000 | 62.400 |

Seismic coefficient= .000 Min. depth of tallest slice= .000 Unit weight of water= 62.400

The factors of safety are determined by the SIMPLIFIED BISHOP method

NSPG= 1 NSRCH= 0 No. of slices= 10 No. of add. radii= 2

No. of points on water table for each case= 6

Under seepage condition 1point no. and coordinates of water table are:
1 .000 36.000 2 247.500 36.000 3 284.423 28.833 4 335.595 15.562 5 350.857 9.457
6 500.000 2.000

point1=( 273.000, 62.000) point2=( 273.000, 42.000) point3=( 352.000, 42.000) NJ= 2 NI= 2
Automatic search will follow after grid with XINC= 10.000 and YINC= 10.000

At point ( 273.000, 62.000) under seepage 1,the radius and the corresponding factor of safety are:
50.587 9.455 44.674 9.596 38.762 9.628 32.849 9.686 26.936 10.021
Lowest factor of safety= 9.455 and occurs at radius = 50.587

At point ( 273.000, 52.000) under seepage 1,the radius and the corresponding factor of safety are:
40.599 9.591 34.688 9.343 28.778 8.942 22.867 8.697 16.956 9.158
26.807 8.836 24.837 8.701 20.897 8.671 18.926 8.620
Lowest factor of safety= 8.620 and occurs at radius = 18.926

At point ( 273.000, 42.000) under seepage 1,the radius and the corresponding factor of safety are:
30.612 10.230 24.749 9.581 18.887 9.180 13.025 9.498 7.162 10.907
22.795 9.374 20.841 9.225 16.933 9.133 14.979 9.343
Lowest factor of safety= 9.133 and occurs at radius = 16.933

At point ( 312.500, 62.000) under seepage 1,the radius and the corresponding factor of safety are:
52.559 2.163 48.955 2.272 45.351 2.506 41.747 3.006 38.143 4.231
Lowest factor of safety= 2.163 and occurs at radius = 52.559

At point ( 312.500, 52.000) under seepage 1,the radius and the corresponding factor of safety are:
42.572 2.277 39.108 2.397 35.645 2.645 32.181 3.148 28.718 4.431
Lowest factor of safety= 2.277 and occurs at radius = 42.572

At point ( 312.500, 42.000) under seepage 1,the radius and the corresponding factor of safety are:
32.584 2.540 29.261 2.671 25.938 2.912 22.616 3.419 19.293 4.753
Lowest factor of safety= 2.540 and occurs at radius = 32.584

At point ( 352.000, 62.000) under seepage 1,the radius and the corresponding factor of safety are:
54.532 3.139 53.467 3.433 52.403 3.723 51.338 5.027 50.274 8.955
Lowest factor of safety= 3.139 and occurs at radius = 54.532

At point ( 352.000, 52.000) under seepage 1,the radius and the corresponding factor of safety are:
44.544 3.487 43.620 3.844 42.696 4.293 41.772 5.536 40.848 9.976
Lowest factor of safety= 3.487 and occurs at radius = 44.544

At point ( 352.000, 42.000) under seepage 1,the radius and the corresponding factor of safety are:
34.557 4.017 33.773 4.473 32.990 5.184 32.207 6.280 31.423 11.474
Lowest factor of safety= 4.017 and occurs at radius = 34.557

For piezometric line No. 1

At point ( 312.500, 62.000) ,RADIUS 52.559
the minimum factor of safety is 2.163

At point ( 312.500, 62.000) under seepage 1,the radius and the corresponding factor of safety are:
52.559 2.163 48.955 2.272 45.351 2.506 41.747 3.006 38.143 4.231
Lowest factor of safety= 2.163 and occurs at radius = 52.559

At point ( 322.500, 62.000) under seepage 1,the radius and the corresponding factor of safety are:
53.059 2.072 50.098 2.228 47.137 2.526 44.175 3.121 41.214 4.673
Lowest factor of safety= 2.072 and occurs at radius = 53.059

At point ( 332.500, 62.000) under seepage 1,the radius and the corresponding factor of safety are:
53.558 2.094 51.240 2.289 48.922 2.635 46.604 3.342 44.285 5.389
Lowest factor of safety= 2.094 and occurs at radius = 53.558

At point ( 322.500, 72.000) under seepage 1,the radius and the corresponding factor of safety are:
63.046 2.013 59.945 2.157 56.843 2.446 53.741 3.032 50.640 4.499
Lowest factor of safety= 2.013 and occurs at radius = 63.046

At point ( 322.500, 82.000) under seepage 1,the radius and the corresponding factor of safety are:
73.034 2.003 69.792 2.125 66.549 2.387 63.307 2.962 60.065 4.352
Lowest factor of safety= 2.003 and occurs at radius = 73.034

At point ( 322.500, 92.000) under seepage 1,the radius and the corresponding factor of safety are:
83.021 2.030 79.639 2.143 76.256 2.375 72.873 2.897 69.490 4.222
Lowest factor of safety= 2.030 and occurs at radius = 83.021

At point ( 332.500, 82.000) under seepage 1,the radius and the corresponding factor of safety are:
73.533 1.977 70.934 2.174 68.335 2.495 65.735 3.172 63.136 4.952
Lowest factor of safety= 1.977 and occurs at radius = 73.533

At point ( 342.500, 82.000) under seepage 1,the radius and the corresponding factor of safety are:
74.033 2.156 72.076 2.342 70.120 2.742 68.163 3.559 66.207 5.945
Lowest factor of safety= 2.156 and occurs at radius = 74.033

At point ( 332.500, 92.000) under seepage 1,the radius and the corresponding factor of safety are:
83.521 1.950 80.781 2.129 78.041 2.446 75.301 3.108 72.561 4.771
Lowest factor of safety= 1.950 and occurs at radius = 83.521

At point ( 332.500, 102.000) under seepage 1,the radius and the corresponding factor of safety are:
93.508 1.955 90.628 2.115 87.747 2.400 84.867 3.052 81.987 4.610
Lowest factor of safety= 1.955 and occurs at radius = 93.508

At point ( 342.500, 92.000) under seepage 1,the radius and the corresponding factor of safety are:
84.020 2.104 81.923 2.282 79.826 2.669 77.729 3.453 75.632 5.670
Lowest factor of safety= 2.104 and occurs at radius = 84.020

At point ( 322.500, 92.000) under seepage 1,the radius and the corresponding factor of safety are:
83.021 2.030 79.639 2.143 76.256 2.375 72.873 2.897 69.490 4.222
Lowest factor of safety= 2.030 and occurs at radius = 83.021

At point ( 335.000, 92.000) under seepage 1,the radius and the corresponding factor of safety are:
83.646 1.961 81.066 2.155 78.487 2.489 75.908 3.175 73.329 4.952
Lowest factor of safety= 1.961 and occurs at radius = 83.646

At point ( 330.000, 92.000) under seepage 1,the radius and the corresponding factor of safety are:
83.396 1.951 80.495 2.116 77.595 2.410 74.694 3.049 71.794 4.610
Lowest factor of safety= 1.951 and occurs at radius = 83.396

At point ( 332.500, 94.500) under seepage 1,the radius and the corresponding factor of safety are:
86.018 1.948 83.243 2.123 80.468 2.436 77.693 3.093 74.918 4.729
Lowest factor of safety= 1.948 and occurs at radius = 86.018

At point ( 332.500, 97.000) under seepage 1,the radius and the corresponding factor of safety are:
88.514 1.947 85.704 2.118 82.894 2.422 80.084 3.079 77.274 4.688
Lowest factor of safety= 1.947 and occurs at radius = 88.514

At point ( 332.500, 99.500) under seepage 1,the radius and the corresponding factor of safety are:
91.011 1.950 88.166 2.116 85.321 2.409 82.476 3.065 79.630 4.648
Lowest factor of safety= 1.950 and occurs at radius = 91.011

At point ( 335.000, 97.000) under seepage 1,the radius and the corresponding factor of safety are:
88.639 1.952 85.990 2.134 83.340 2.466 80.691 3.144 78.042 4.860
Lowest factor of safety= 1.952 and occurs at radius = 88.639

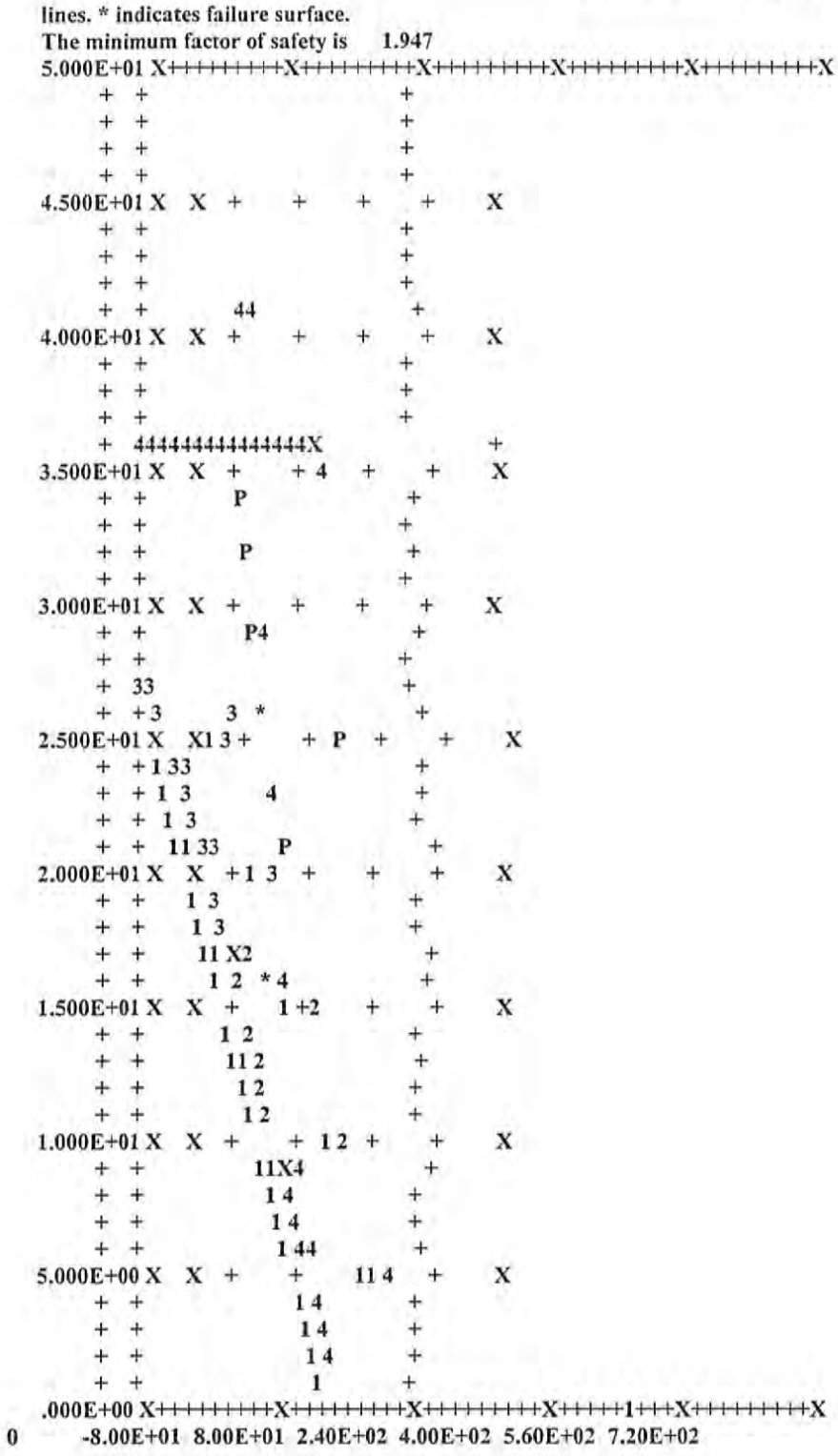
At point ( 330.000, 97.000) under seepage 1,the radius and the corresponding factor of safety are:
88.390 1.959 85.419 2.111 82.448 2.388 79.477 3.022 76.506 4.534
Lowest factor of safety= 1.959 and occurs at radius = 88.390

For piezometric line No. 1

At point ( 332.500, 97.000) ,RADIUS 88.514
the minimum factor of safety is 1.947

1

Cross section in distorted scale. Numerals indicate boundary line no.
If there area more than 10 bound. lines, alphabets will then be used. P indicates
Piezometric line. If a portion of Piezometric line coincides with
the ground or another boundary line, only the ground or boundary
line will be shown. X indicates intersection of two boundary


lines. * indicates failure surface.
The minimum factor of safety is 1.947
5.000E+01
4.500E+01
4.000E+01
3.500E+01
3.000E+01
2.500E+01
2.000E+01
1.500E+01
1.000E+01
5.000E+00
.000E+00
0
-8.00E+01 8.00E+01 2.40E+02 4.00E+02 5.60E+02 7.20E+02