# Liberty Quarry

# Water Usage and Demand Study

By

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April 17, 2008

## INTRODUCTION

Granite Construction Company's (Granite) proposed Liberty Quarry Project (Project) will establish a quarry and ancillary facilities on an approximately 155-acre site located in Southwest Riverside County at the San Diego County line. The project will include a concrete batching plant, asphalt plant, aggregate crushing and screening plant, and an aggregate washing plant capable of producing coarse and fine washed sands and gravel.

The purpose of this report is to provide detailed analysis of the water usage for the project and to look at feasible mitigation measures that might be used to reduce the amount of water that might be used for the project. This report can be used in the analysis of the water usage impacts in the Environmental Impact Report being prepared by Riverside County as well as the Water Supply Assessment (WSA) that might be prepared by Western Municipal Water District (WMWD). The early anticipated water usage for the project was estimated at 500 ac-ft per year. Water is typically used at aggregate resource facilities for dust control, Portland cement concrete production and washing aggregate, as well as personal use. This more refined analysis indicates that the actual maximum amount of water used if the plant was operating at a rate of 5 million tons per year would range from 369 to 398 ac-ft per year as discussed below.

## DESCRIPTION OF PROJECT SCENARIOS

To begin, a brief description of the aggregate washplant is necessary. Every washplant differs slightly in design and set-up, but the basic purpose is the same; the removal of fine materials from the finished products. Dry, crushed aggregate is fed into the plant, and water is used throughout the plant with specific types of equipment to produce finished coarse and/or fine washed products. Efficient washplant design ensures that large quantities of water needed for washing is conserved (recycled) during the washing process. Washplants may contain settling ponds, thickener tanks, belt presses, screens, cyclones, multiple water tanks, and other equipment used for cleaning aggregate and conserving water. For this project, an estimated 300,000 gallon non-potable water tank will be used in the washplant for water supply and recirculation of re-used water. Necessary make-up water for the project is supplied by the water district from a large potable supply tank nearby. Other specific designs, equipment and water losses for this project are described in greater detail below.

Two different scenarios were analyzed to determine total water usage for the project. In both scenarios a high quantity of water will be recycled and reused—constantly recirculating throughout the plants. However, water loss out of the system will occur at many points throughout the process and this cumulative water loss represents the "make-up" water that must be supplied in order to run the project.

**Scenarios 1 & 2 – Description**

Both scenarios include the following:

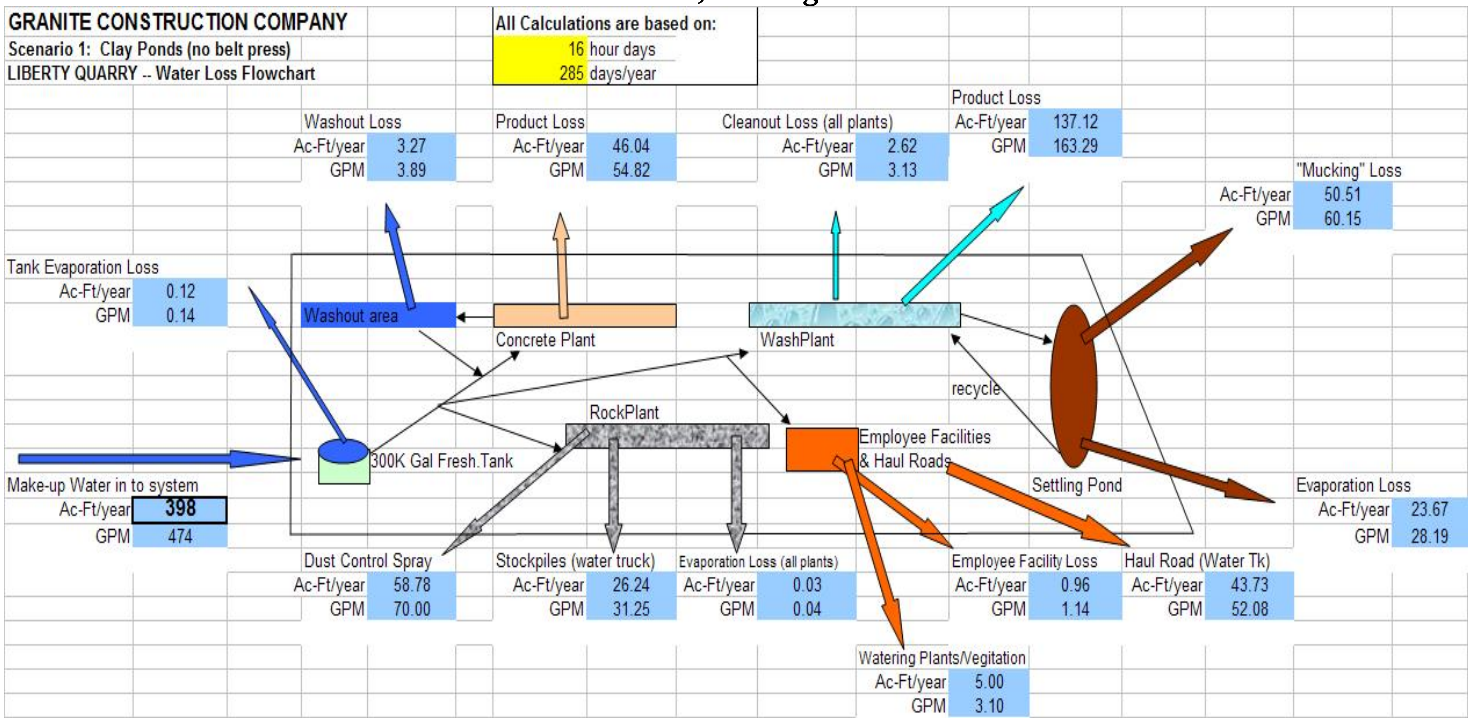
1) Rock Plant (part of "aggregate plant")
2) Concrete Plant with washout area
3) Wash Plant (part of "aggregate plant")
4) Employee facilities (offices, bathrooms, ect)
5) Haul Roads
6) Stockpile areas
7) 300K Gallon water storage tank (open to atmosphere)

Both scenarios will be very similar except for differences in washplant design. Scenario differences are described below.

**Scenario 1 – Settling Pond (figure 1)**

This scenario includes the use of a 3 acre settling pond at the washplant to capture ultra-fine material (minus #100 mesh). The washing process begins with an initial wet screening process of the feed. Any oversize material is screened off and the remaining slurry of sands and fines falls through the screen(s) to a slurry holding tank. The slurry of sands and fines is then pumped through a bank of cyclones. Cyclones use centrifugal force to separate sands from the finer, deleterious clays. The slurry of clays/fines (aka overflow) from the cyclones report to the settling ponds. The clean sand slurry from the cyclones (aka underflow) is sent across dewatering screens and finally reports out as finished product. Meanwhile, the fine/clay slurry pumped to the settling ponds settles out and clean water is recycled back to the plant. Not all water is recycled back from settling ponds, as ponds require the removal ("mucking") of the settled fines 3-4 times per year in order to maintain workable pond volumes. Water is also lost through evaporation. Water losses are displayed in figure 1.

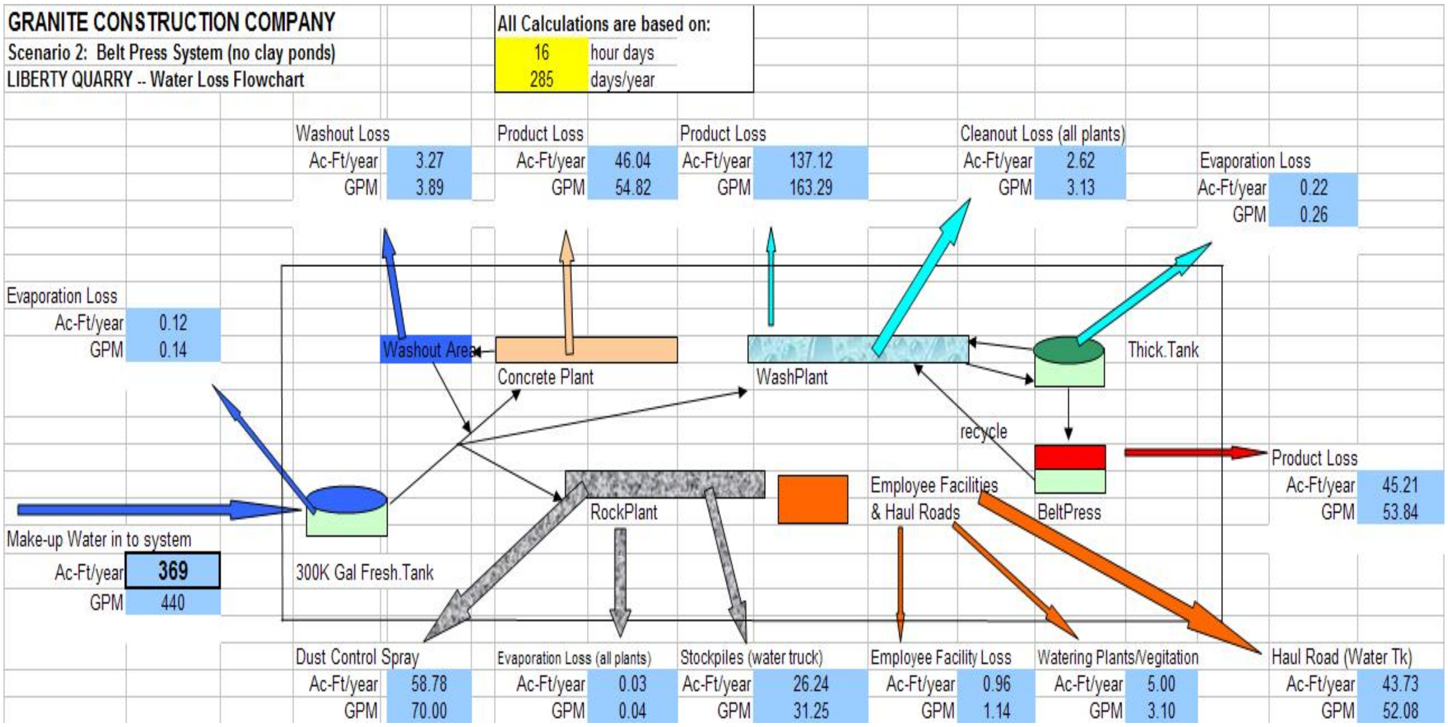
**Figure 1**
**Scenario #1, Settling Ponds**




**Scenario 2 – Belt Press System (figure 2)**

Settling ponds are eliminated in Scenario 2 and replaced with a belt press system. This scenario closely resembles scenario 1, however the slurry of clays/fines (aka overflow) from the cyclones reports to a thickener tank (aka clarifier). A thickener is a large, circular tank used to settle out fines from the incoming slurry. At the top of the thickener tank, overflow from a weir system allows fresh water to be recycled back to the washplant. After settling in the bottom of the thickener tank, the fines/clays (minus 100 mesh material) are pumped to a belt press system. Simply put, a belt press system squeezes and dewaters the fines/clay slurry between layers of fine cloth and then discharges these dewatered fines into a workable stockpile. The water drained from the belt press during this dewatering processes is recycled back to the plant. This scenario eliminates the need for a settling pond. Water losses are displayed in figure 2.

**Figure 2**
**Scenario #2, Belt Press System**




## SYSTEM WATER LOSSES

Figures 1 and 2 summarize the water losses in both scenarios, respectively. These losses are derived from Tables 1 and 2 (Appendix A), which are models used to determine water losses for both scenarios. Detailed explanations of the plant set-up, production calculations and water losses (with example calculations) follow. This explanation follows closely along with tables 1 and 2 (appendix A).

### Project Assumptions, Product Produced and Water Usage

Liberty quarry's aggregate plant will operate at approximately 2200 tons/hour and produce approximately 5,000,000 tons/year. Of that, as much as 2,000,000 tons/year of manufactured sand will be produced. During production, a certain percentage of this material is washed and turned into washed sand product. A certain percentage of coarse product from the aggregate plant is also washed. In order to keep up with product demand and optimize production, the washplant must operate approximately 16 hours per day, producing the following quantities of finished products:

Coarse Washed Product: **203 tph or 675,000 tons/year**
Fine Washed Products/Sands: **365 tph or 1,215,000 tons/year**

As previously discussed, fines/clays are produced as a byproduct from the washing action of these finished coarse and sand products. To determine dry TPH of clays (fines, minus 100 mesh) produced, a representative sample washplant feed gradation was used from Rosemary's Mountain Quarry (similar geologic conditions). It is assumed that 13% (by weight) of washplant feed will consist of minus 100 mesh material.

TPH of clays (fines) produced:
Coarse Fraction: 203 tph X .13 = 26 TPH fines
Sand Fraction: 365 tph X .13 = 47 TPH fines

In order to meet finished product specifications, a majority of these fines must be cleaned and removed during the washing process. Using an average industry standard, it is assumed that 3 gpm of water is used per ton per hour produced during coarse product washing. It is assumed that 6 gpm of water per tph product is needed to wash the sand fraction.

GPM needed to wash material:
Coarse Fraction: 203tph X 3 gpm = 608 gpm
Fine Fraction: 365tph X 6 gpm = 2187 gpm
Total GPM needed to wash material = 608 + 2187 = 2795 gpm

It is important to note that *this quantity does not represent lost water*, rather water needed for the washing process. This number is important in determining water recycle percentages.

**Lost Water**
Water that is "lost" out of the system in both scenarios (figures 1 and 2) must be replaced by an equal amount of "make-up" water into the system. This make-up water represents the total gallons per minute needed to supply to run the project. All water-loss locations throughout the plants are described in detail below along with supporting example calculations.

**Concrete Plant Losses (both scenarios)**
Production water required in concrete mixes is 100% lost (sold in concrete product). It is assumed that the concrete batching plant will produce approximately 500,000 cubic yards per year. It is estimated that 30 gallons of water will be used per $yd^3$ of concrete. (500,000 cubic yard)X(30gal/$yd^3$)X(100%) = 15,000,000 gallons per year water loss = 46 ac-ft/year = 55 gpm.

A concrete truck washout area is also used at batching plants. Although this washout area is designed to recycle water, it is conservatively assumed that 60% of the water used for washing will be lost. It is also assumed that 10% of the total production water quantity will be required for the washout area.

(9,000,000 gpy)X(10%)X(60%) = 540,000 gallons per year water loss = 1.65 ac-ft/year = 2 gpm.

---> Total water loss at concrete plant = 15,540,000 gallons per year = 48 ac-ft/year = 57 gpm.

**Roads, Stockpiles, Employee Facility and Watering Vegetation Losses (both scenarios)**

Quarry haul roads will be sprayed down periodically with an environmentally safe solution of magnesium chloride to maintain water absorption for dust control. Water trucks will be required for daily dust control on haul roads and aggregate stockpiles. Assuming 285 operating days/year, 8 total water truckloads per day (5 for roads, 3 for stockpile areas) and 10,000 gal/truck to water the roads and stockpile areas:

(8 truckloads/day)X(285days/year)X(10,000gal/truckload) = 22,800,000 gallons per year = 70 ac-ft/year = 83 gpm.

(Or 44 ac-ft/year and 26 ac-ft/year for the roads and stockpiles, respectively).

Employee facilities (offices, bathrooms, ect) will require an estimated 1250 gallons per day of water for an estimated 250 days per year.

(1250 gal/day) X (250 days/year) = 312,500 gallons per year lost water = 1 ac-ft/year = 2.6 gpm.

Water will be needed to water plants and vegetation during the mining and concurrent reclamation process. It is assumed that 1 acre per year of bench area will be vegetated as mining progresses (assuming 75 acres of bench area / 75 years to strip site = 1 acre per year). It is assumed that it will take 5 years to establish plants so the maximum amount watered each year is 5 acres. It is also assumed that 12" of water per year will be needed for native plants:

(12 inches/year) / (12inches/ft) = 1 ft/year X 5 acres = 5 ac-ft/year

**Rock Plant Losses (both scenarios)**

Dust control at the rock plant consists of high pressure water sprays on screens, conveyors and crushers. A small tire wash area prevents trucks from tracking fugitive dust onto public roads. It is assumed that 70 GPM is need for water sprays and 6 GPM is needed for the tire wash station. 100% of water is assumed lost from water sprays and 10% is assumed loss from the tire wash station.

(285 days/year)X(16 hours/day)X(70gpm)X(100%)X(60min/hr) = 19,152,000 gal/year = 59 ac-ft/year for the water sprays.

(285 days/year)X(16 hours/day)X(6gpm)X(10%)X(60min/hr) = 164,160 gal/year = 0.5 ac-ft/year for the tire wash station.

Total water lost for tire wash and water spray dust control = 19,316,160 gallons/year = 59.5 ac-ft/year.

## Wash Plant Losses

### Wash Plant Scenario 2 (Belt Press System)

Washplant water losses using this plant scenario (figure 2) include evaporation from thickener and fresh water tanks, miscellaneous clean-up water, and moisture lost (sold) in coarse, fine, and belt press products. From a previous calculation, it is assumed that 26 and 47 TPH of clays (minus 100 mesh) are produced from the coarse and fine/sand product fractions, respectively. This fraction will be dewatered and discharged as product off of the belt press at an estimated 25% moisture content.

(26+47TPH)X(25%)X(2000lb/ton)/(60min/hr)/(8.34lb/gal) = 73 GPM water lost

(73 gal/min) X (60min/hr) X (3,333 op.hrs/year) = 14,598,540 gallons/year water lost in belt press product = 45 ac-ft/year = 53 gpm

The coarse and fine finished products are assumed to have 6% and 12% moisture contents, respectively. From previous calculations it was determined that finished products would be produced at a rate of 203 tph (coarse fraction) and 365 tph (fine/sand fraction).

(203 tons/hr) X (6%) X (2000lb/ton) X (3,333 ophrs/yr) / (8.34 lb/gal) =

9,735,237 gal/yr water lost in coarse product = 29.9 ac-ft/year = 35.6 gpm

Similarly,

(365 tons/hr) X (12%) X (2000lb/ton) X (3,333 ophrs/yr) / (8.34 lb/gal) =

35,008,489 gal/yr water lost in fine/sand product = 107.4 ac-ft/year = 128 gpm

Clean-up water (used on and off throughout the day) is assumed used at a rate of 100gpm for a combined total of 30 minutes per day.

(285 days/yr)X(100gal/min)X(60min/hr)X(0.5hrs/day) = 855,000 gallons/year clean-up water use = 2.62 ac-ft/year = 3 gpm

Evaporation in this scenario comes from the thickener tank, fresh water tank, and other miscellaneous plant locations. Figure 3 (appendix A) displays the evaporation map and total evaporation loss for both scenarios. For example, the thickener evaporation loss is determined as follows:

(1257sqft surface area)*((90in/yr)/(12in/ft))*(7.48gal/cuft) = 70,518 gallons/year = 0.2 ac-ft/year

Evaporation for other areas is determined in the same fashion.

### Wash Plant Scenario 1 (Clay Pond System)

Water losses from this scenario (figure 1) are determined in a similar fashion. Coarse and fine product water losses are the same in both scenarios. However, this scenario does not include any belt press – thus no belt press product water losses. Instead, water loss occurs from the settling pond. Additionally, the pond must be cleaned out (“mucked”) multiple times per year in order to maintain working pond volumes and efficiency. Evaporation from the pond is calculated as previously explained.

From quarry phasing plans, it is assumed that the pond dimensions are 250'X550' by 40' in depth. It is assumed that the pond must be mucked 4 times per year, at 25% of the total pond volume each time. The moisture content of the mucked fines will vary depending on location and time between mucking periods, however it is assumed that pond fines will be mucked at 40% moisture content. Accordingly:
(250X550X40)X(25%)X(40%)X(4times/yr)X(7.48gal/cuft) = 16,456,000 gallons/yr lost = 50.5 ac-ft/year

**SUMMARY**

An extensive engineering analysis of both scenarios has determined that Granite Construction Company's proposed Liberty Quarry Project will require an inflow of approximately 434 - 468 gpm during operating hours based on a 16 hour work day 6 days per week. Total annual water demand is determined to be approximately 364 - 393 ac-ft/yr. Tables 1 and 2 display these detailed and summarized calculations. The engineering estimates used in this report are as conservative and accurate as possible and obtained from industry experts with years of combined experience.

# APPENDIX A

Water Loss Tables
Evaporation Model

**Table 1**
**Settling Ponds, Scenario #1**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GRANITE CONSTRUCTION COMPANY** | | | | | | | | | Ckiser | | | |
| **Scenario 1: Clay Ponds (no belt press)** | | | | **Estimate of Water Usage & Needs** | | | | | 12/19/2007 | | | |
| **LIBERTY QUARRY** | | | | **Revision 2 (Kiser)** | | | | | Yellow = inputs | | | |
| | | | | | | | | | Blue = outputs | | | |
| | **Tons per Year:** | 5,000,000 | | | | | | | | | | |
| | | **Aggregate Plant** | | | | **Concrete Plant** | | **Roads/Facilities** | | | | |
| | Water Consumption | Wash Plant Coarse | Wash Plant Sands (WCS & Plaster) | Tire Wash | Dust Control | Production Water | Wash out | Quarry Haul Roads | Stockpile Area | Employee Facilities | Watering Plants/Vegetation | |
| **MAX HRS** | Hours per Day | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 24 | |
| | Op. Days per Year | 285 | 285 | 285 | 285 | 280 | 280 | 285 | 285 | 250 | 365 | |
| | Operate Total hrs | 4,560 | 4,560 | | | | | | | | | |
| AGGFLOW HR | Total Production (tph) | 1,500 | 1,500 | | | 300 | 100 | | | | | |
| | Plant Eff | 0.90 | 0.90 | | | | | | | | | |
| | Adj. Total Prod (tph) | 1,350 | 1,350 | | | | | | | | | |
| | Production Split | 15% | 27% | | | | | | | | | |
| | Product (Tph) | 203 | 365 | | | | | | | | | |
| | Total Run Hrs/YR | 3,333 | 3,333 | | | | | | | | | |
| | Annual Production | 675,000 | 1,215,000 | | | 500,000 | 0 | | | | | |
| | Dry TPH of clays produced (minus100mesh) | 26 | 47 | | | | | | | | | |
| | % Moisture in Pond Clay Product (by weight) | 60% | 60% | | | | | | | | | |
| | Gallons/year water loss "mucking" ponds | 16,456,000 | | | | | | | | | | |
| | Gallons/year Seepage Loss from Lined Pond | 0 | | | | | | | | | | |
| | Water (GPM) Used per Tph | 3.0 | 6.0 | | | | | | | | | |
| | % Water (by weight) in Concrete | | | | | 7.00% | | | | | | |
| | Total GPM Used | 608 | 2,187 | 6 | 70 | | | | | | | |
| | % Moisture in Products | 6% | 12% | | | | | | | | | |
| | % Wash Moisture Loss | 6% | 12% | 10% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| | GPM water loss in products | 49 | 175 | | | 100% | 60% | | | | | |
| | Clean-up Water Loss -- all Plants (GPY) | 855,000 | | | | | | | | | | |
| | Water Truck Capacity | | | | | | | 10,000 | 10,000 | | | |
| | Water Truck Loads per Day | | | | | | | 5 | 3 | | | |
| | Total Evap Loss (all plants) | 7,764,633 | | | | | | | | | | |
| | Total Water Loss Per Year (Gallons) | 34,787,863 | 34,964,029 | 164,160 | 19,152,000 | 15,000,000 | 900,000 | 14,250,000 | 8,550,000 | 312,500 | 1,629,145 | 129,709,697 |
| | Make-up Water per Day (gal) | 122,063 | 122,681 | 576 | 67,200 | 53,571 | 3,214 | 50,000 | 30,000 | 1,250 | 4,463 | 455,019 |
| | Make-up Water gpm | 127 | 128 | 1 | 70 | 56 | 3 | 52 | 31 | 1 | 3 | 472 |
| | Total Acre-Feet per Year | 107 | 107 | 1 | 59 | 46 | 3 | 44 | 26 | 1 | 5 | **398** |

**Table 2**
**Belt Press System, Scenario #2**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GRANITE CONSTRUCTION COMPANY** | | | | | | | | | Ckiser | | | |
| Scenario 2: Belt Press System (no ponds) | | | | **Estimate of Water Usage & Needs** | | | | | 12/19/2007 | | | |
| LIBERTY QUARRY | | | | **Revision 2 (Kiser)** | | | | | Yellow = inputs | | | |
| | | | | | | | | | Blue = outputs | | | |
| | **Tons per Year:** | | 5,000,000 | | | | | | | | | |
| | | **Aggregate Plant** | | | | **Concrete Plant** | | **Roads/Facilities/Vegetation** | | | | |
| | Water Consumption | Wash Plant Coarse | Wash Plant Sands (WCS & Plaster) | Tire Wash | Dust Control | Production Water | Wash out | Quarry Haul Roads | Stockpile Area | Employee Facilities | Watering Plants/Vegetation | |
| **MAX HRS** | Hours per Day | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 24 | |
| | Op. Days per Year | 285 | 285 | 285 | 285 | 280 | 280 | 285 | 285 | 250 | 365 | |
| | Operate Total hrs | 4,560 | 4,560 | | | | | | | | | |
| AGGFLOW HI | Total Production (tph) | 1,500 | 1,500 | | | 300 | 100 | | | | | |
| | Plant Eff | 0.90 | 0.90 | | | | | | | | | |
| | Adj. Total Prod (tph) | 1,350 | 1,350 | | | | | | | | | |
| | Production Split | 15% | 27% | | | | | | | | | |
| | Product (Tph) | 203 | 365 | | | | | | | | | |
| | Total Run Hrs/YR | 3,333 | 3,333 | | | | | | | | | |
| | Annual Production | 675,000 | 1,215,000 | | | 500,000 | 0 | | | | | |
| | Dry TPH of clays produced (minus100mesh) | 26 | 47 | | | | | | | | | |
| | Water (GPM) Used per Tph | 3.0 | 6.0 | | | | | | | | | |
| | % Moisture in Belt Press Clay Product (by weight) | 25% | 25% | | | | | | | | | |
| | GPM of water loss from Belt Press Product | 26 | 47 | | | | | | | | | |
| | % Water (by weight) in Concrete | | | | | 7.00% | | | | | | |
| | Total GPM Used | 608 | 2,187 | 6 | 70 | | | | | | | |
| | % Moisture in Products | 6% | 12% | | | | | | | | | |
| | % Wash Moisture Loss | 6% | 12% | 10% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| | GPM water loss in products | 49 | 175 | | | 100% | 60% | | | | | |
| | Clean-up Water Loss -- all Plants (GPY) | 855,000 | | | | | | | | | | |
| | Water Truck Capacity | | | | | | | 10,000 | 10,000 | | | |
| | Water Truck Loads per Day | | | | | | | 5 | 3 | | | |
| | Total Evap Loss (all plants) | 121,400 | | | | | | | | | | |
| | Total Water Loss Per Year (Gallons) | 15,949,422 | 44,433,453 | 164,160 | 19,152,000 | 15,000,000 | 900,000 | 14,250,000 | 8,550,000 | 312,500 | 1,629,145 | 120,340,680 |
| | Make-up Water per Day (gal) | 55,963 | 155,907 | 576 | 67,200 | 53,571 | 3,214 | 50,000 | 30,000 | 1,250 | 4,463 | 422,145 |
| | Make-up Water gpm | 58 | 162 | 1 | 70 | 56 | 3 | 52 | 31 | 1 | 3 | 438 |
| | Total Acre-Feet per Year | 49 | 136 | 1 | 59 | 46 | 3 | 44 | 26 | 1 | 5 | **369** |

**Figure 3**
**Evaporation Map and Model**


**KEY–1 SURFACE ACRE POND**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | 30 in/yr | 1.7 ac/ft/yr | 555,000 gal/yr | G | 90 in/yr | 5.3 ac/ft/yr | 1,728,000 gal/yr |
| B | 40 in/yr | 2.3 ac/ft/yr | 750,000 gal/yr | H | 100 in/yr | 5.8 ac/ft/yr | 1,891,000 gal/yr |
| C | 50 in/yr | 2.9 ac/ft/yr | 945,000 gal/yr | I | 110 in/yr | 6.4 ac/ft/yr | 2,087,000 gal/yr |
| D | 60 in/yr | 3.5 ac/ft/yr | 1,140,000 gal/yr | J | 120 in/yr | 7.0 ac/ft/yr | 2,282,000 gal/yr |
| E | 70 in/yr | 4.1 ac/ft/yr | 1,337,000 gal/yr | K | 130 in/yr | 7.6 ac/ft/yr | 2,478,000 gal/yr |
| F | 80 in/yr | 4.7 ac/ft/yr | 1,532,000 gal/yr | L | 140 in/yr | 8.2 ac/ft/yr | 2,673,000 gal/yr |

| | | | | |
|---|---|---|---|---|
| | Evap Losses at LQ Washplant | | | |
| from map - | Loss per year = | 90 | in/yr | |
| | Open Items | Surf.Area | | |
| | | $ft^2$ | Gallons Lost/year | |
| | 40' Thickener Tank | 1257 | 70,518 | |
| | 30' Freshwater Tank | 707 | 39,663 | |
| | Screens/Plant Areas | 200 | 11,220 | |
| | 3ac Settling Pond | 137,500 | 7,713,750 | |
| | TOTAL ANNUAL | | | |
| | EVAPORATION LOSS | | **7,764,633** | Gallons |
| | (with settling ponds--scen#2) | | | |
| | TOTAL ANNUAL | | | |
| | EVAPORATION LOSS | | **121,400** | Gallons |
| | (without ponds -- Scen#1) | | | |