

PINEY POINT GYPSUM STACK SYSTEM PROCESS WATER MANAGEMENT EVALUATION

Scoping Meeting

February 3, 2016

Call in # 1-888-670-3525

Participant Code: 657-719-7821 press #

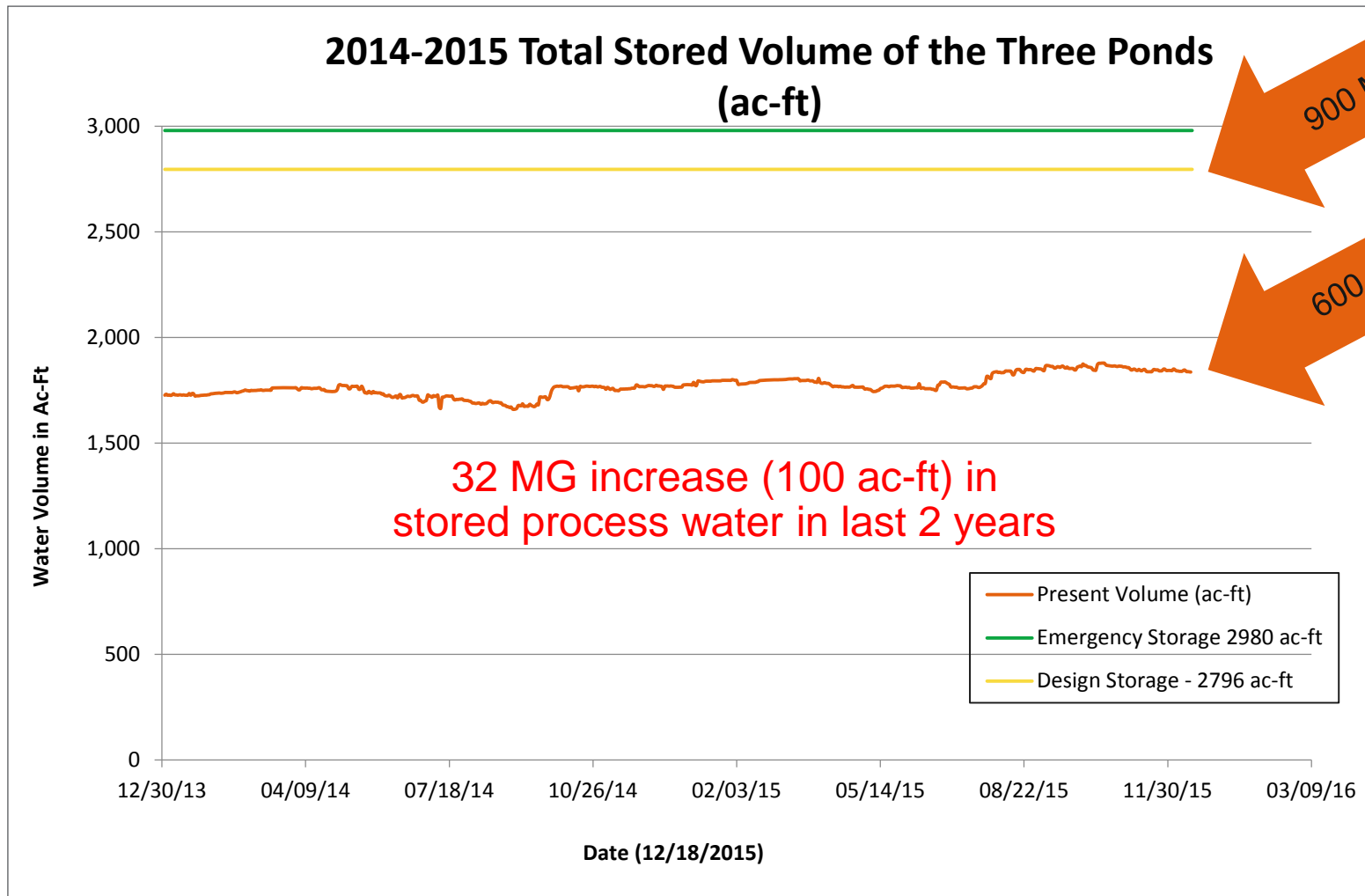
Agenda

- Introductions
- Meeting Objectives
- Discussion Items
 - Water Balance Projections/ Treatment Rates
 - Influent Quality
 - Treated Effluent Discharge Standards
 - Technology Matrix
 - Potential Treatment Combinations
 - Evaluation Criteria
- Feedback

Existing Conditions

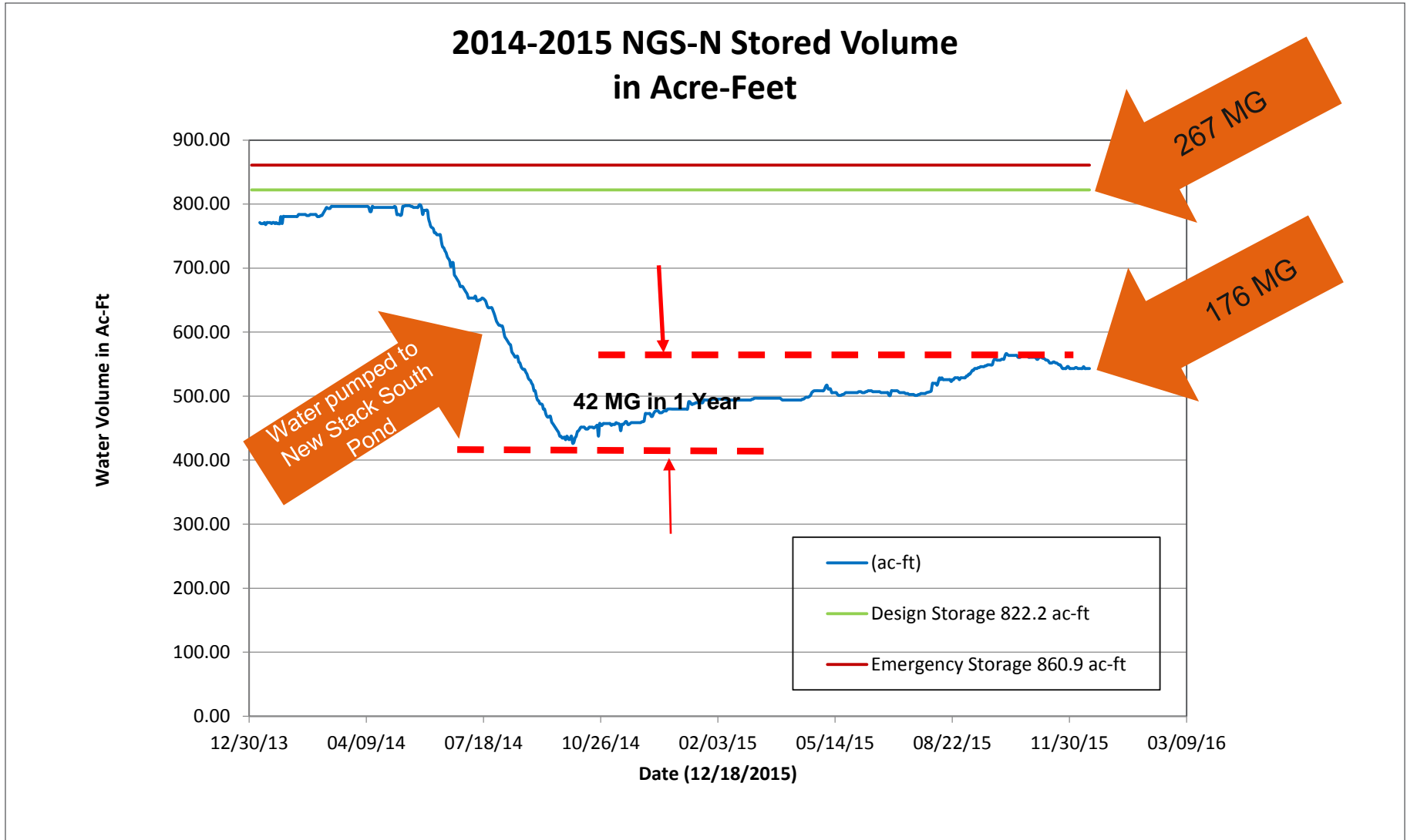


Dec 2015 Water Balance

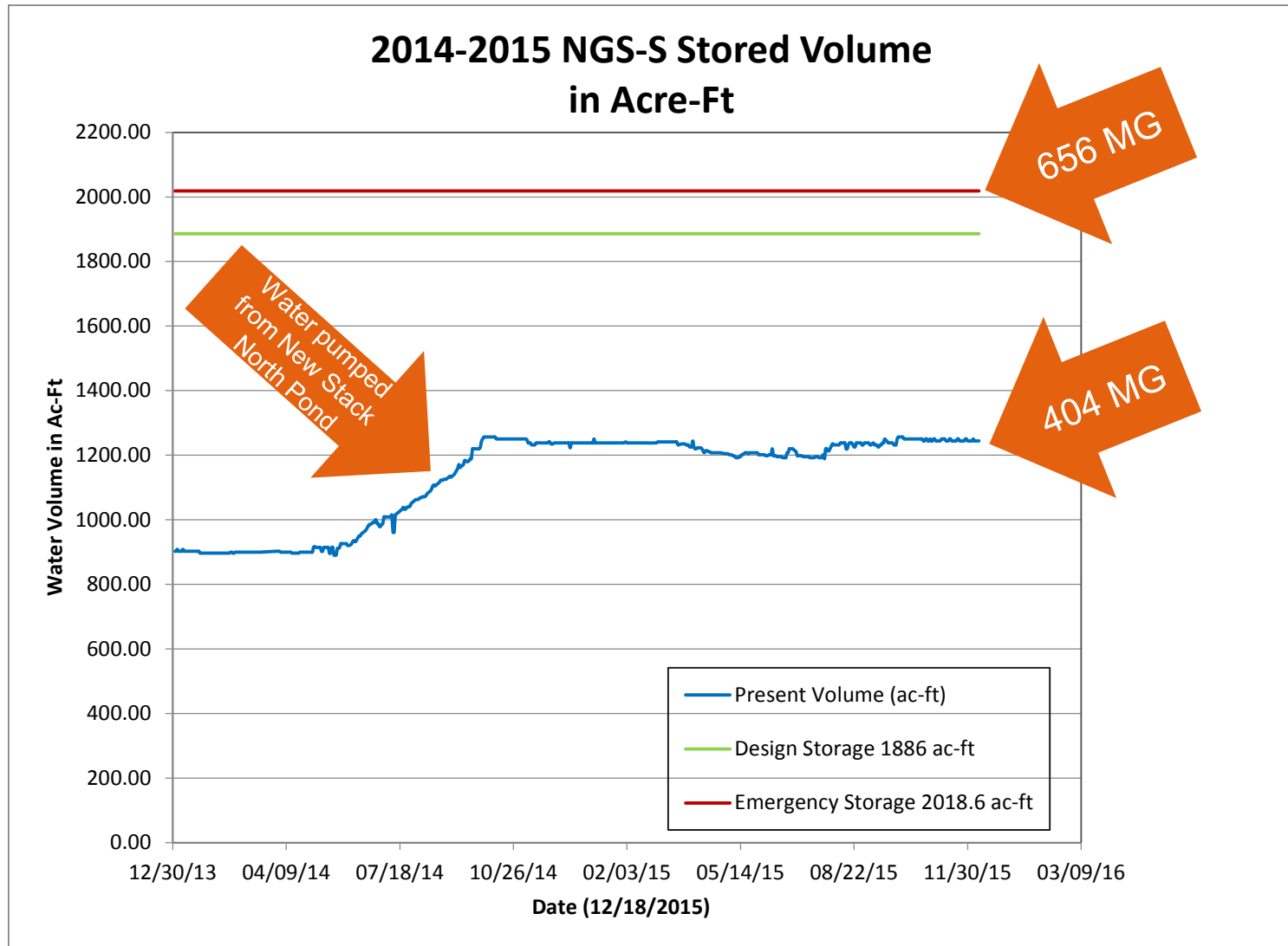


Assumption: 1 Ac-ft = ~0.325 MG

Dec 2015 Water Balance



Dec 2015 Water Balance

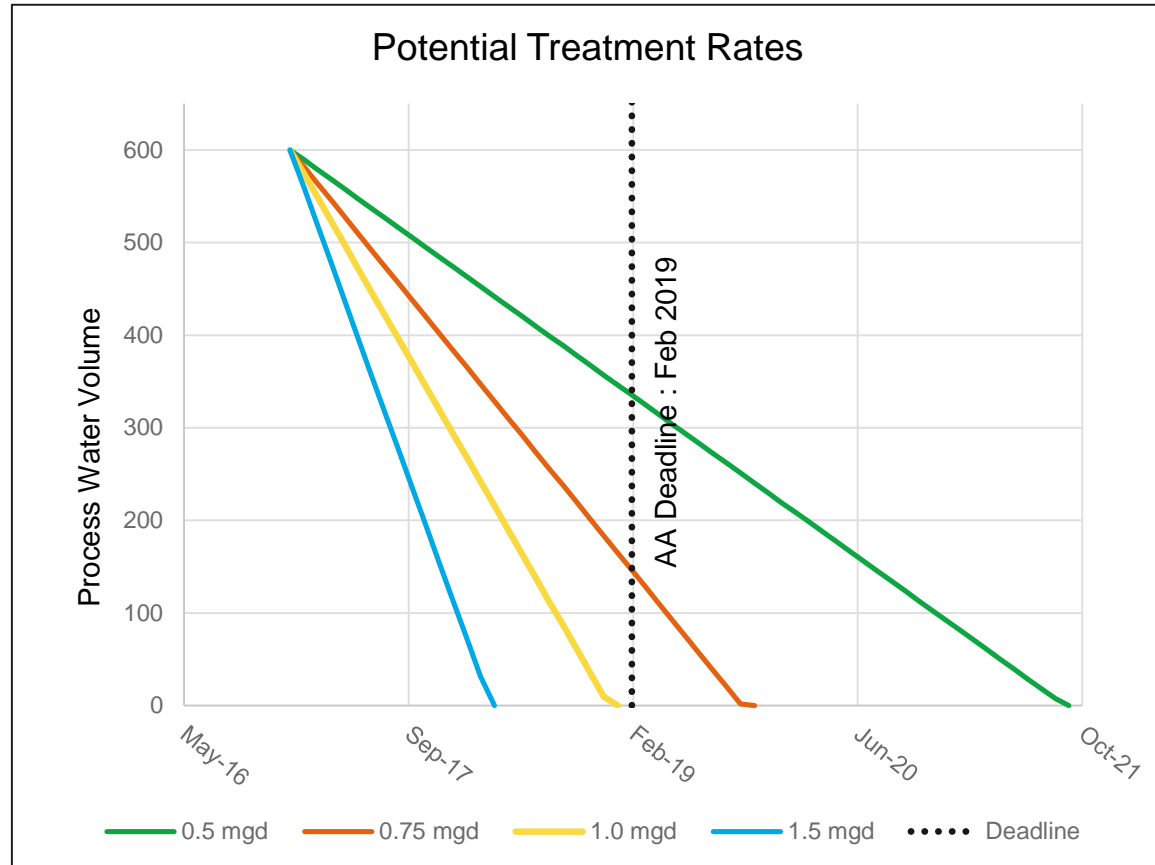


Water Balance

110 gpm [58 MG/Y] Seepage
~60 inch/year [194 MG] rain



600 MG
Stored
Water

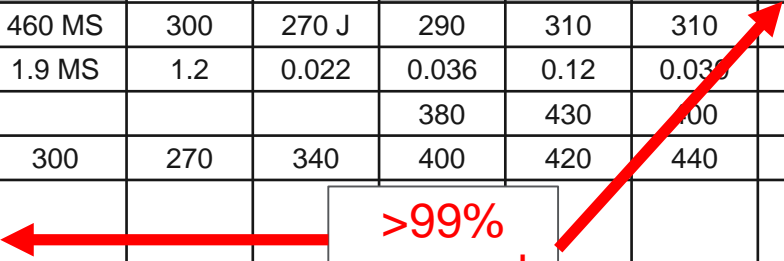


~73 MG/Y NGS-N Spray System
~60 inch/year [194 MG] Evaporation

Influent Quality (NGS-N)

| Location ID: | | POTW Limits | Administrative Agreement Max. Limits | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N |
|-----------------------------|----------|----------------|--|----------|----------|----------|----------|----------|----------|----------|
| Date Collected: | | | | 04/07/09 | 12/10/10 | 10/26/11 | 03/01/12 | 01/08/14 | 09/23/14 | 10/07/15 |
| Sample name: | Units | | | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N |
| Radionuclides | | | | | | | | | | |
| Alpha, Total | pCi/L | -- | 15 | | 7.6 | 16.8 | | | | |
| Nutrients | | | | | | | | | | |
| Ammonia-N | mg/L | -- | Report | 350 | | | 290 | 320 | 340 | 340 |
| Kjeldahl Nitrogen | mg/L | -- | -- | 460 MS | 300 | 270 J | 290 | 310 | 310 | 330 |
| NO2NO3-N | mg/L | -- | -- | 1.9 MS | 1.2 | 0.022 | 0.036 | 0.12 | 0.036 | 0.018 |
| O-Phosphate-P | mg/L | -- | -- | | | | 380 | 430 | 400 | 420 |
| Total-P | mg/L | -- | Report | 300 | 270 | 340 | 400 | 420 | 440 | 400 |
| Total Nitrogen | mg/L | -- | 0.9 tons/ year, 5 yr avg | | | | | | | |
| Ammonia, Unionized (as NH3) | mg/L | -- | 0.02 | | | | | | | |
| General Chemistry | | | | | | | | | | |
| Chloride | mg/L | 287 | -- | 160 | 120 | 1,600 | 1,500 | 1,300 | 1,200 | 1,000 |
| Fluoride | mg/L | -- | 10 | 9.1 | 14 | 17 | 19 | 19 | 20 | 17 |
| pH | SU | 5.0 - 11.5 | 6.0 - 8.5 | 5.31 | 5.09 | 4.74 | 5.08 | 5.02 | 4.93 | 4.81 |
| Specific Conductance | µmhos/cm | -- | greater of 1.5XBG or 1275 | 9,979 | 8,475 | 11,660 | 11,989 | 10,242 | 11,201 | 10,246 |

>99%
removal



Influent Quality (Phase II Drain)

| Location ID: | | POTW Limits | Administrative Agreement Max. Limits | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N |
|---|----------|----------------|--|---------------------------|----------------|------------------|---------------------------|-------------------------------|-------------------------------|--------------------|
| Date Collected: | | | | 12/10/10 | 11/02/11 | 11/18/11 | 01/08/14 | 03/21/14 | 04/03/14 | 08/12/15 |
| Sample name: | Units | | | Phase II (NGS-N) Drain | NGS-N DRAIN | NGS-N Seepage | Phase II (NGS-N) Drain | NGS-N Toe Seepage Location | NGS-N Toe Seepage Location | NGS-N Toe Ditch |
| Metals | | | | | | | | | | |
| Iron | mg/L | -- | 1.0 | 52.4 A | | | 52.3 | | 37.1 | |
| Radionuclides | | | | | | | | | | |
| Alpha, Total | pCi/L | -- | 15 | | | | | | | |
| Nutrients | | | | | | | | | | |
| Ammonia-N | mg/L | -- | Report | | 0.17 | | 280 | 230 | 200 | |
| Kjeldahl Nitrogen | mg/L | -- | -- | 260 | | | 260 | 250 | 200 | |
| NO ₂ NO ₃ -N | mg/L | -- | -- | 0.14 IJ | | | 0.017 | 0.051 | 0.018 | |
| O-Phosphate-P | mg/L | -- | -- | | | | 330 | | | |
| Total-P | mg/L | -- | Report | 380 | 0.47 | | 350 | 490 | 350 | |
| Total Nitrogen | mg/L | -- | 0.9 tons/ year, 5 yr avg | | | | | | | |
| Ammonia, Unionized (as NH ₃) | mg/L | -- | 0.02 | | | | | | | |
| General Chemistry | | | | | | | | | | |
| Chloride | mg/L | 287 | -- | 67 A | 37 A | | 67 | | 52 | |
| Fluoride | mg/L | -- | 10 | 13 | | | 14 | | 32 | |
| pH | SU | 5.0 - 11.5 | 6.0 - 8.5 | 5.28 | | 5.28 | 5.34 | 4.31 | 4.89 | 4.47 |
| Specific Conductance | µmhos/cm | -- | greater of 1.5XBG or 1275 | 3,461 | | 3,461 | 6,930 | 3,209 | 4,575 | |

Influent Quality (NGS-S)

| Location ID: | | POTW Limits | Administrative Agreement Max. Limits | NGS-S | NGS-S |
|------------------------------------|----------|-------------|--------------------------------------|----------|----------|
| Date Collected: | | | | 09/23/14 | 10/07/15 |
| Sample me: | Units | | | NGS-S | NGS-S |
| Nutrients | | | | | |
| Ammonia-N | mg/L | -- | Report | 190 | 210 |
| Kjeldahl Nitrogen | mg/L | -- | -- | 190 | 210 |
| NO ₂ NO ₃ -N | mg/L | -- | -- | 0.004 | 0.005 |
| O-Phosphate-P | mg/L | -- | -- | 190 | 160 |
| Total-P | mg/L | -- | Report | 200 | 170 |
| General Chemistry | | | | | |
| Chloride | mg/L | 287 | -- | 5,700 | 5,800 |
| Fluoride | mg/L | | 10 | 6.4 | 3.1 |
| Sodium | mg/L | -- | -- | 3,830 | 3,800 |
| Sulfate | mg/L | -- | -- | 3,300 | 3,400 |
| pH | SU | 5.0 - 11.5 | 6.0 - 8.5 | 4.87 | 3.62 |
| Specific Conductance | µmhos/cm | -- | greater of 1.5XBG or 1275 | 21,777 | 21,994 |

Influent Quality (LPWS)

| Location ID: | | POTW Limits | Administrative Agreement Max. Limits | LPWS | LPWS | LPWS | LPWS | LPWS |
|------------------------------------|----------|----------------|--|----------|----------|----------|----------|----------|
| Date Collected: | | | | 12/29/10 | 10/26/11 | 03/01/12 | 09/23/14 | 10/07/15 |
| Sample me: | Units | | | LPWS | LPWS | LPWS | LPWS | LPWS |
| Metals | | | | | | | | |
| Iron | mg/L | -- | 1.0 | 7.11 | 8.21 A | 15.5 | 4.68 | 3.2 |
| Nutrients | | | | | | | | |
| Ammonia-N | mg/L | -- | Report | | | 330 | 270 | 230 |
| Kjeldahl Nitrogen | mg/L | -- | -- | 330 | 320 | 330 | 240 | 250 |
| NO ₂ NO ₃ -N | mg/L | -- | -- | 0.082 l | 0.023 | 0.026 | 0.022 | 0.059 |
| O-Phosphate-P | mg/L | -- | -- | | | 700 | 330 | 270 |
| Total-P | mg/L | -- | Report | 510 | 380 | 660 | 320 | 280 |
| General Chemistry | | | | | | | | |
| Chloride | mg/L | 287 | -- | 89 | 1,300 | 790 | 500 | 390 |
| Fluoride | mg/L | -- | 10 | 32 | 18 | 34 | 24 | 17 |
| Field Parameters | | | | | | | | |
| pH | SU | 5.0 - 11.5 | 6.0 - 8.5 | 4.13 | 5.38 | 3.74 | 4.85 | 5.47 |
| Specific Conductance | µmhos/cm | -- | greater of 1.5XBG or 1275 | 7,662 | 9,815 | 10,147 | 7,773 | 7,075 |
| Turbidity | NTU | -- | 29 | 141 | 108 | 159 | | |

Design Considerations: Scaling

| Location ID: | | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N |
|-----------------|-------|----------|----------|----------|----------|----------|----------|----------|
| Date Collected: | | 04/07/09 | 12/10/10 | 10/26/11 | 03/01/12 | 01/08/14 | 09/23/14 | 10/07/15 |
| Sample name: | Units | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N | NGS-N |
| Calcium | mg/L | 602 | 459 | 506 | 542 A | 519 | 520 | 459 |
| Magnesium | mg/L | 334 | 241 | 296 | 305 A | 273 | 272 | 229 |
| Sulfate | mg/L | 5,900 | 4,400 | 3,900 | 4,000 | 3,900 | 3,900 | 4,000 |

| Location ID: | | NGS-S | NGS-S |
|-----------------|-------|----------|----------|
| Date Collected: | | 09/23/14 | 10/07/15 |
| Sample me: | Units | NGS-S | NGS-S |
| Calcium | mg/L | 354 | 305 |
| Magnesium | mg/L | 539 | 530 |
| Sulfate | mg/L | 3,300 | 3,400 |

| Location ID: | | LPWS | LPWS | LPWS | LPWS | LPWS |
|-----------------|-------|----------|----------|----------|----------|----------|
| Date Collected: | | 12/29/10 | 10/26/11 | 03/01/12 | 09/23/14 | 10/07/15 |
| Sample me: | Units | LPWS | LPWS | LPWS | LPWS | LPWS |
| Calcium | mg/L | 472 | 528 A | 550 | 420 | 378 |
| Magnesium | mg/L | 159 | 213 A | 206 | 166 | 142 |
| Sulfate | mg/L | 3,600 | 3,200 | 3,500 | 3,100 | 3,000 |

Scaling Issues

- pH < 5: Iron Phosphate
- pH > 6.5: Struvite, Calcium Carbonate, Gypsum

High TDS:

- Gypsum scale issues with brine concentrate – membrane separation technologies
- High pH for ammonia stripping – gypsum and calcium carbonate scale



Iron Phosphate
 $[\text{Fe}_3(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O}]$



Calcium Carbonate $[\text{CaCO}_3]$



Struvite $[\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}]$



Gypsum $[\text{CaSO}_4 \cdot 2\text{H}_2\text{O}]$

POTW Discharge Limits

Manatee County Utilities Department Local Pretreatment Discharge Limits

| <u>CONSTITUENT</u> | <u>LIMIT mg/L</u> |
|--|-------------------|
| Arsenic, total | 2.51 |
| Cadmium, total | 0.73 |
| Chromium, total | 9.90 |
| Copper, total | 28.48 |
| Cyanide, total | 4.70 |
| Lead, total | 1.87 |
| Mercury, total | 0.38 |
| Molybdenum, total | 1.26 |
| Nickel, total | 11.08 |
| Selenium, total | 2.11 |
| Silver, total | 16.06 |
| Zinc, total | 4.78 |
| 5 Day Carbonaceous Biological Oxygen Demand (BOD5) | 7290 |
| Chloride | 287 |
| Total Suspended Solids (TSS) | 1830 |

| Parameters (units) | Discharge Limitations | | |
|--|-----------------------|-----------------|---------------|
| | Daily Minimum | Monthly Average | Daily Maximum |
| pH (SU) (See Part 4i) | 6.0 | Report | 8.5 |
| Oxygen, Dissolved (DO) (MG/L) | 5.0 | Report | N/A |
| Specific Conductance (UMHOS/CM) | N/A | Report | See Part 4j |
| Turbidity (NTU) (See Part 4k) | N/A | Report | 29 |
| Temperature (C), Water (DEG.C) (See Part 4i) | N/A | Report | Report |
| Total Suspended Solids (MG/L) | N/A | Report | Report |
| Fluoride, Total (as F) (MG/L) | N/A | Report | 10.0 |
| Beryllium, Total (UG/L) (See Part 4e) | N/A | Report | Report |
| Iron, Total (as Fe) (MG/L) | N/A | Report | 1.0 |
| Phosphorus, Total (as P) (MG/L) | N/A | Report | Report |
| Phosphorus, Total (as P) (LBS/DAY) (See Parts 4f, g & h) | N/A | Report | Report |
| Nitrogen, Total (as N) (MG/L) | N/A | Report | Report |
| Nitrogen, Total (as N) (LBS/DAY) (See Parts 4f, g & h) | N/A | Report | Report |
| Nitrogen, Ammonia, Total (as N) (MG/L) (See Part 4i) | N/A | Report | Report |
| Ammonia, Un-ionized (as NH ₃) (MG/L) (See Part 4i) | N/A | Report | 0.02 |
| Acute Whole Effluent Toxicity, 96 Hour LC50 (Ceriodaphnia dubia) | 100% | | See Part 4n |
| Acute Whole Effluent Toxicity, 96 Hour LC50 (Cypripinella leedsii) | 100% | | See Part 4n |

Administrative Agreement Discharge Limits

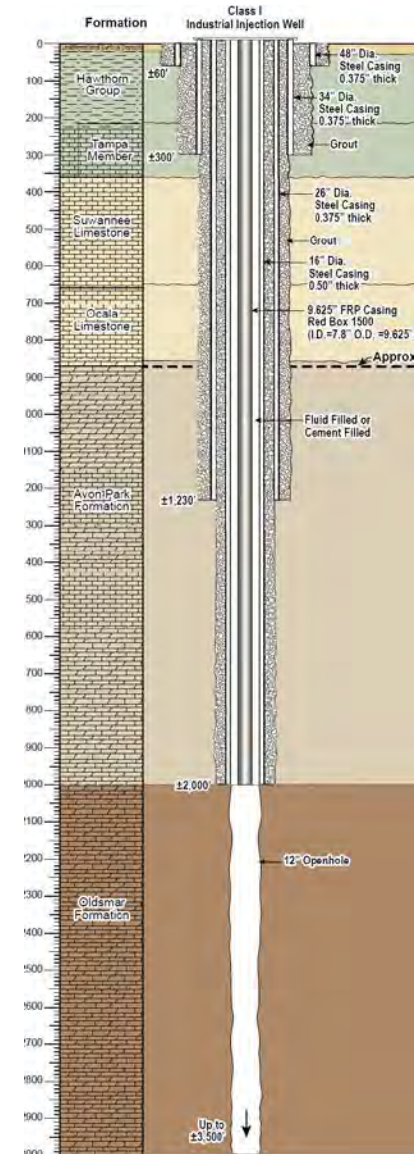
UIC Injection Well

Manatee County / CH2MHill Effort:

- Class I Injection Well, 1-2 mgd
- USDW: 900 ft bls
- Exploratory Well (EW-2) drilled to 1,600 ft
- Recommended Well Depth: ~3,500 ft bls
- Pretreatment: pH adjustment, filtering required

Potential Path Forward:

- Evaluate sacrificial injection well (1-2 year lifespan)
- Additional drilling required
- Explore feasibility of injecting from 1,350 to 2,000 ft bls
- Geochemistry evaluation/modelling, bench scale permeability testing
- 18-24 month implementation timeline (testing, permitting, construction)
- 9-5/8 inch diameter, 400 psi injection pressure
- Capital and O&M costs will likely be >\$2.50/ gallon estimated historically



Treated Effluent Disposal Options

| Option | Treatment Driver | Comments |
|--------|---|---|
| POTW | <ul style="list-style-type: none"> • Chloride • pH • TDS | <ul style="list-style-type: none"> • Seepage Drain water does not exhibit elevated chloride concentrations • Evaluate direct discharge 80-100 gpm (Phase II Drain) to POTW ?? |
| NPDES | <ul style="list-style-type: none"> • Total Nitrogen • Iron • Fluoride • pH • Turbidity • Aquatic Toxicity | <ul style="list-style-type: none"> • Discharge to Buckeye Road Ditch <ul style="list-style-type: none"> • Estimate stormwater nitrogen loading • >99% removal required to meet 0.9 ton/year limit • Variance or Exemption ? • Pipeline ? • Feedback on phosphorus discharge limits. |
| UIC | <ul style="list-style-type: none"> • pH • TSS • Scaling | <ul style="list-style-type: none"> • Privately owned v/s Manatee County ? |



Technology Matrix

| Constituent | Redox Sensitive | Precip/Co-Precip w/ Sedimentation and/or Filtration | Adsorption | Aeration | Membrane Separation | Biological | Ion Exchange |
|-----------------|-----------------|---|------------|----------------------|---------------------|------------------|--------------|
| NH ₄ | | Limited | Limited | Yes ¹ | Yes | Yes ³ | Yes |
| PO ₄ | | Yes | Limited | | Yes | Yes ⁴ | Yes |
| SO ₄ | | Yes ² | Limited | | Yes | Yes ⁵ | Limited |
| Cl | | | | | Yes | | |
| Mn | Yes | Yes | Yes | Limited ¹ | Limited | | Yes |
| Fe | Yes | Yes | Yes | Yes | Limited | | Yes |
| Ca | | Yes | No | No | Yes | | Yes |
| Mg | | Yes | No | No | Yes | | Yes |

1. High pH required for best success (~11)
2. Gypsum solubility: 1,800 to 2,000 mg/L
3. Aerobic biological treatment for ammonia; anoxic biological treatment to treat nitrates/nitrites.
4. Aerobic biological treatment.
5. Anaerobic treatment for sulfate; high dosage of carbon required (e.g., 1.0 lbs methanol for every 0.75 lbs sulfate as sulfur (SO₄-S). Aerobic polishing step likely required.

In Situ Treatment

Demonstrated Success:

- pH Adjustment
- Chemical Amendment
- Biological treatment



100 Million-Gallon Pit Lake – Before and During Treatment



~3.0 Billion-Gallon Pit Lake – Before and During Treatment

Take Advantage Of Long Hydraulic Retention Time

Treatment Alternatives

| | Alternative Description | Primary Treatment ¹ | Disposal Method | Comments |
|---|-------------------------|--------------------------------|--------------------|----------------------------|
| 1 | Phase II Seepage Drain | None | POTW | 0.1 mgd ² |
| 2 | Combined Process Water | pH adjustment | UIC Injection Well | |
| 3 | | Electrodialysis Reversal (EDR) | POTW | |
| 4 | | Ex-Situ Treatment | NPDES | Precipitation and Aeration |
| 5 | | In-Situ Treatment | NPDES | |
| 6 | | Reverse Osmosis | NPDES | |

¹ Pretreatment and/or post-treatment, and management of residuals will be required for the primary treatment technology to be effective, and for the treated effluent to meet discharge limits

²Assumes a max POTW permit capacity of 0.1 mgd

Evaluation Criteria

1. Effectiveness
2. Implementability
3. Reliability
4. Schedule
5. Cost
6. Community Acceptance
7. Permitting Requirements

Final Deliverable Format

- Evaluation Table
- PFDs
- Cost Estimate