Kayenta WWTP Improvements Project

Existing Plant Decommissioning Plan

The following demolition plan is intended to provide a general overview and guideline for the removal, salvage, relocation, and abandonment of existing wastewater treatment plant equipment and structures as identified in the contract drawings and specifications. Actual procedures, limits, and sequencing will be determined and coordinated in the field in consultation with, and written approval of, the ENGINEER and OWNER to reflect site conditions, safety requirements, and operational constraints. The actual procedures will be documented in writing as they are developed and executed. Any deviation will be documented and accompanied by red line as-builts.

1. General Overview

- The work involves demolition, removal, salvage, relocation, and/or abandonment of existing wastewater treatment facilities and equipment as identified in the drawings.
- All work will be conducted in accordance with paragraph 40.g (entitled "Decommission") of the Partial Consent Decree (PCD).
- All demolition activities should minimize disruption to the ongoing operation of the plant.

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2. Safety Requirements

- All work must comply with Federal, State, and local safety regulations.
- Hazardous materials may be present (e.g., asbestos, lead-based paint, mercury, residual sewage, chemicals). The CONTRACTOR must implement proper handling, removal, and disposal measures.
- CONTRACTOR must ensure that personnel are trained and equipped for all safety risks, including confined spaces, electrical and chemical hazards, and heavy equipment operations.

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3. Coordination

- Only materials identified in drawings or approved by the ENGINEER shall be demolished, salvaged, removed, relocated, or abandoned.
- Provide **minimum four working days' notice** to ENGINEER and OWNER prior to start of work or plant shutdowns.
- Temporary services must be provided to maintain critical operations during interruptions.
- Protect existing underground utilities and overhead during construction.
- Demolition limits must follow drawings.
- Areas outside demolition limits should remain undisturbed unless necessary for demolition.

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4. Demolition Procedures

4.1 General Demolition

- Remove all materials associated with demolished equipment and structures in accordance with Paragraph 40.g of the PCD and within 180-days of the replacement plant completion.
- Transport and dispose of all demolished materials offsite, to a permitted landfill; on-site burning or disposal is prohibited.
- Repair any demolition performed in excess of requirements.

4.2 Concrete, CMU, and Reinforcing Steel

- As required, cut concrete cleanly using saws or core drills.
- Cut and cap reinforcing steel as instructed by the ENGINEER and OWNER.
- For any structures abandoned in place, finish surfaces to a uniform, smooth, and level condition.

4.3 Concrete Embedded Items

- Remove anchor bolts, rebar, conduit at least 1 inch below final surface.
- Coat exposed rebar and patch concrete with approved bonding agents and non-shrink grout.
- Plug empty pipes/conduits with fireproof sealant where required.

4.4 Utilities

- In coordination with OWNER, excavate, support, or relocate electrical, water, sanitary, and storm utilities as exposed.
- Permanently close any demolished utility lines per utility owner in coordination with the OWNER.

4.5 Electrical Demolition

- Coordinate with the OWNER to disconnect and remove all electrical equipment.
- Abandon underground conduits and cables in place, in compliance with PCD paragraph 40.g, and labeling as “ABANDONED IN PLACE” on red line as-built.
- Remove conductors from conduits no longer in use; install pull tapes as needed.
- Extend or re-route circuits to remain operational as required.

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5. Salvage and Relocation

- Salvage materials as directed by OWNER; store and protect them during relocation.

---

6. Abandonment of Existing Structures

6.1 Structural Abandonment

- Pump out tanks or piping into existing lagoons.
- Remove and salvage mechanical components per NTUA direction.
- Break walls down to 2 feet below grade; core drill floors, catch basins, and slabs to allow drainage.
- Cap and plug all relevant utilities and pipes.
- Backfill below-grade areas with approved material (<3” diameter, free of organic debris) to top of ground.

6.2 Piping and Conduits

- Cap demolished ends with watertight plugs to prevent soil or water entry.
- Pressurized services: install restrained caps or plugs.
- Gravity services: plug with minimum 6-foot concrete caps.

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7. Documentation and Inspection

- CONTRACTOR shall maintain records of demolition, salvage, relocation, and abandonment activities.
- Coordinate final inspection with ENGINEER and OWNER prior to site turnover or backfill completion.

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8. Scope of Work

All equipment identified below shall be demolished, abandoned, or relocated only after NTUA informs Contractor, in writing, that (1) the new plant is operational and (2) no part of the existing lagoon treatment system is further needed. If work takes place prior to new plant being operational, a bypass plan shall be provided to maintain plant operation and treatment.

1. Existing Headworks (this is not the old Headworks behind the Lab Bldg.)
    a. Influent control panel
        i. Set up temporary pump and follow IPS Bypass Plan.
        ii. Follow electrical LOTO procedures.
        iii. Upgrade existing control panel.
        iv. Remove existing pumps and replace with new units.
    b. Power swap-out to new source
        i. Coordinate with NTUA for power transition.
        ii. Set up temporary pump and use manual bar screen to keep system in operation.
        iii. Follow electrical LOTO procedures.
        iv. Swap power over to the new source.
    c. Existing Mechanical Bar Screen and Washer Compactor
        i. Refer to equipment's MOPO.
        ii. Use manual bar screen to temporarily screen influent while old power is being disconnected and new power is connected.
        iii. Disconnect old power and connect to new source.
        iv. Verify that equipment is operational.
2. Generator & Structure (North of Cells 1B and 2).
    a. Confirm new generator is operational prior to demolition.
    b. Coordinate with NTUA to disconnect power to structure.
    c. Remove all existing electrical equipment including transformer, service entrance panel, meter, disconnect, and weatherhead.
    d. Demolish generator structure; salvage existing generator to NTUA.
    e. Demolition of additional electrical equipment north of structure is TBD pending COR approval.
3. Existing Cell 1A/1B.
    a. Ensure equipment is deenergized.
    b. Demo electrical per demolition procedures.
    c. Demolish electrical junction boxes between Cells A1 and 4.
    d. Remove suspended aerator and cables.
4. Standby Generator at Chlorination Area
    a. Salvage generator to NTUA

    b. Demolish electrical equipment per electrical procedures.
5. Existing CL2/SO2 Contact Chamber
    a. Demolish electrical equipment per electrical procedures.
    b. Demolish structure per structural abandonment and demolition procedures.
6. Existing Lab Room (at Chlorination Area)
    a. Demolish per demolition procedures.
    b. Coordinate with NTUA to salvage equipment.
7. Existing Effluent Sampler and Shed
    a. Relocate sampler and shed to new disinfection location.
    b. Demolish foundation per demolition procedures.
8. Existing Chemical Building.
    a. Coordinate chemical disposal with NTUA prior to work.
    b. Demolish per above demolition and safety procedures.

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9. Dewatering and Sludge Handling

Once the replacement activated sludge treatment plant achieves compliance with NPDES permit discharge limits, controlled dewatering of Lagoon Cells 1A, 1B, 2, 3, and 5 shall commence.

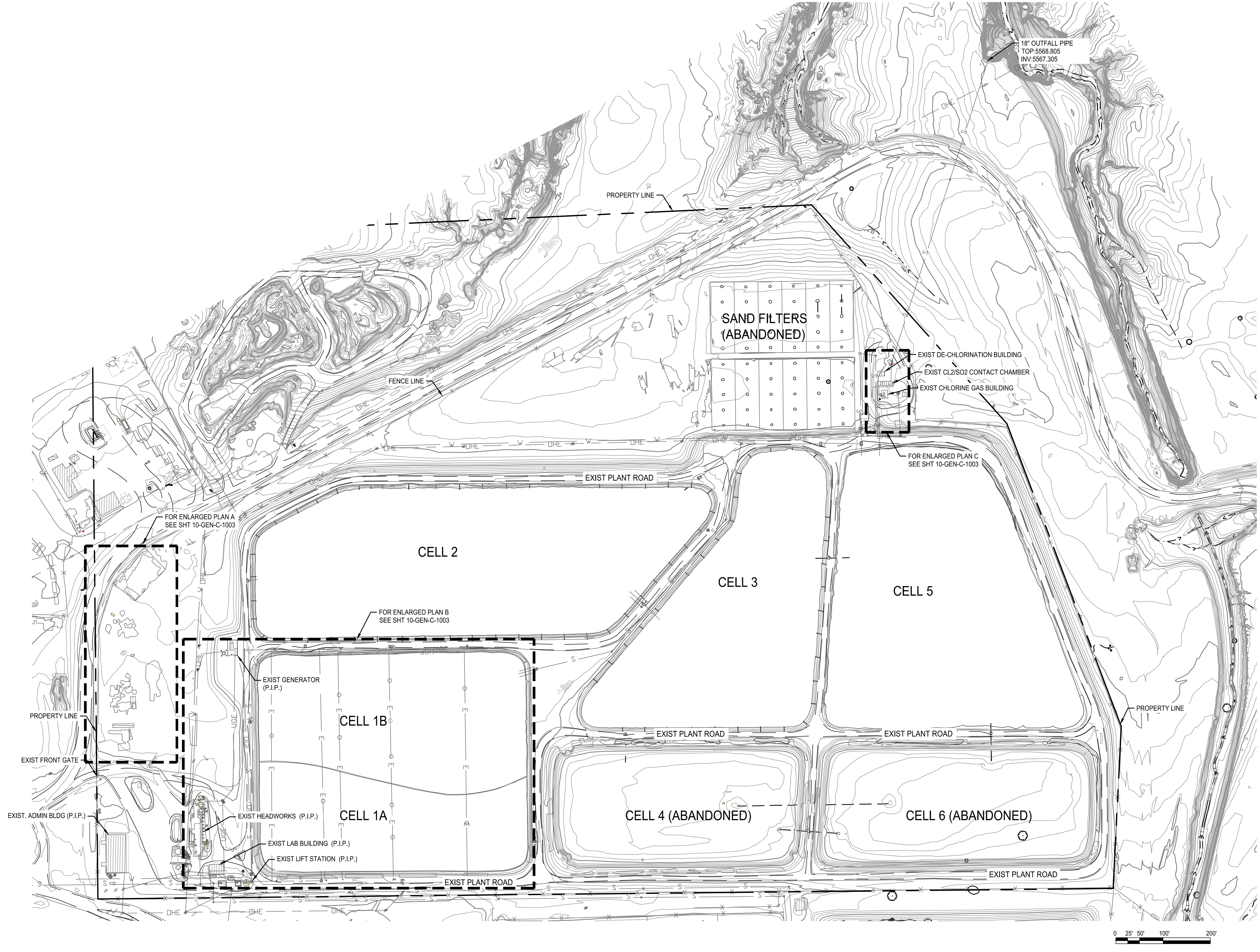
1. Liquids shall be pumped to the headworks of the new treatment plant at rates proportional to influent flow to prevent hydraulic overloading or biological upset.
2. Lagoon Cell 4 shall not be dewatered under this plan. Sludge was removed from Cell 4 in 2024, and the cell was converted to a Continuous Flow Intermittent Discharge (CFID) system in 2025. Cell 4 will be retained as the emergency bypass lagoon for the new activated sludge treatment plant.
3. Lagoon Cell 6 shall not receive liquids under this dewatering program. The cell is abandoned and the sludge was removed in 2024 and disposed of under the Chinle biosolid disposal project. NTUA intends to convert Cell 6 into a permanent biosolid storage surface disposal facility. This project plan under development by NTUA. Cell 6 shall only receive dried sludge after regulatory approval and construction of the biosolids facility.
4. Sludge remaining in Cells 1A, 1B, 2, 3, and 5 shall be allowed to dry through natural evaporation. Once sufficiently dried, sludge shall be shaped into windrows to enhance drying efficiency and managed to control odors, vectors, and dust.
5. All historical sludge quantities identified in the prior sludge assessment performed by H&S Environmental, LLC in 2020, shall be increased by ten percent (10%) per year to account for continued deposition since the last characterization. NTUA crews are conducting a new sludge depth assessment to compare current conditions to the 2020 baseline.

Table 1: Estimate of current sludge accumulation by cell in dry tons.

	Average Actual Measured Sludge Blanket Thickness (ft) (2020)	Tons of Dry Solids (2020)	Tons of Dry Solids (2026)
Cell # 1A	**2.360**	**394**	**591**
Cell # 1B	**1.760**	**318**	**477**
Cell # 2	**0.580**	**118**	**177**
Cell # 3	**0.810**	**325**	**488**
Cell # 5	**0.800**	**169**	**254**

6. Prior to final sludge disposal, additional laboratory testing for heavy metals and regulated constituents shall be conducted to confirm compliance with 40 CFR Part 503. All dried sludge from Cells 1A, 1B, 2, 3, and 5 shall be transported to Cell 6 for permanent disposal following approval and construction of the biosolids disposal facility.
7. All synthetic liners will be removed, segmented and hauled to an approved disposal facility.
8. Cell walls will be reshaped by grading to a slope that poses no safety hazard.

Attachment: Demolition Plan Set



WSP

4221 BALLOON PARK RD NE
ALBUQUERQUE, NM 87109

PROJECT:
KAYENTA WWTP IMPROVEMENTS PROJECT

NAVAJO TRIBAL UTILITY AUTHORITY

WSP PROJECT No:
2151700032

REVISIONS

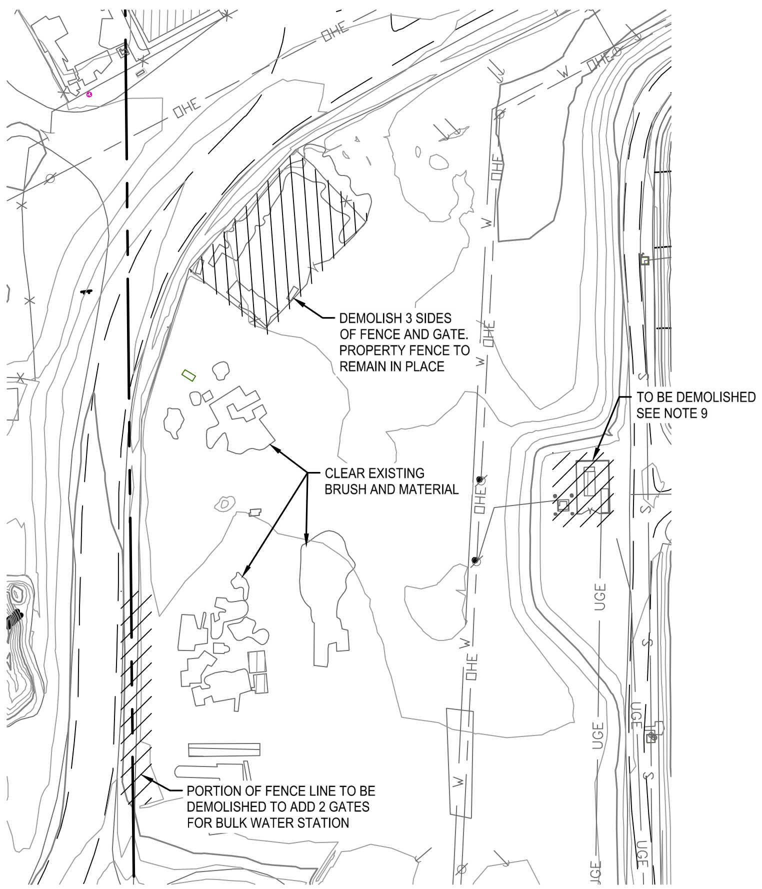
NO.	DATE	DESCRIPTION

DESIGNED BY:	DDM
DRAWN BY:	DDM
CHECKED BY:	JCB
DATE:	04NOV2022

SHEET TITLE:
EXISTING SITE PLAN

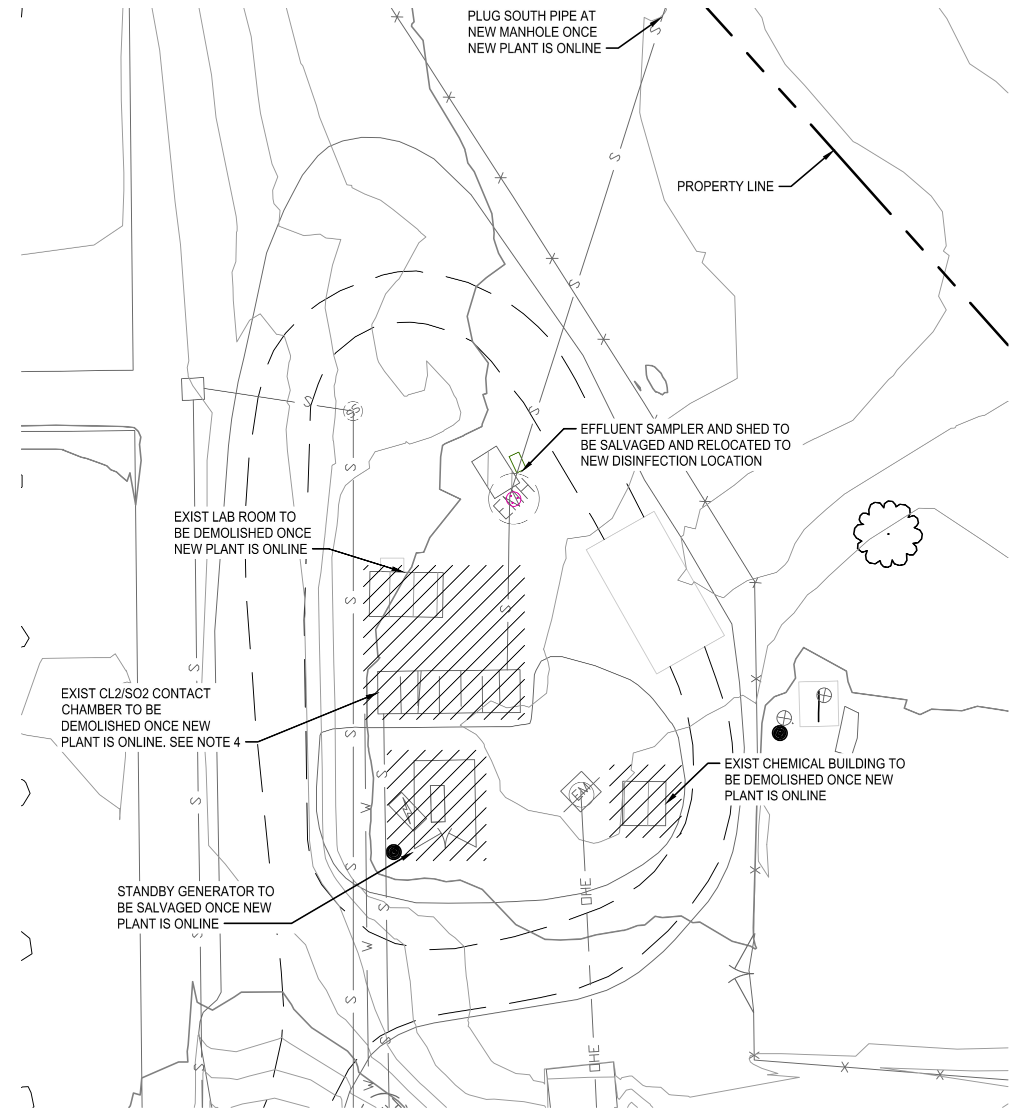
SHEET NUMBER:	REV. #
10-GEN-C-1002	0

SHEET 9 OF 223



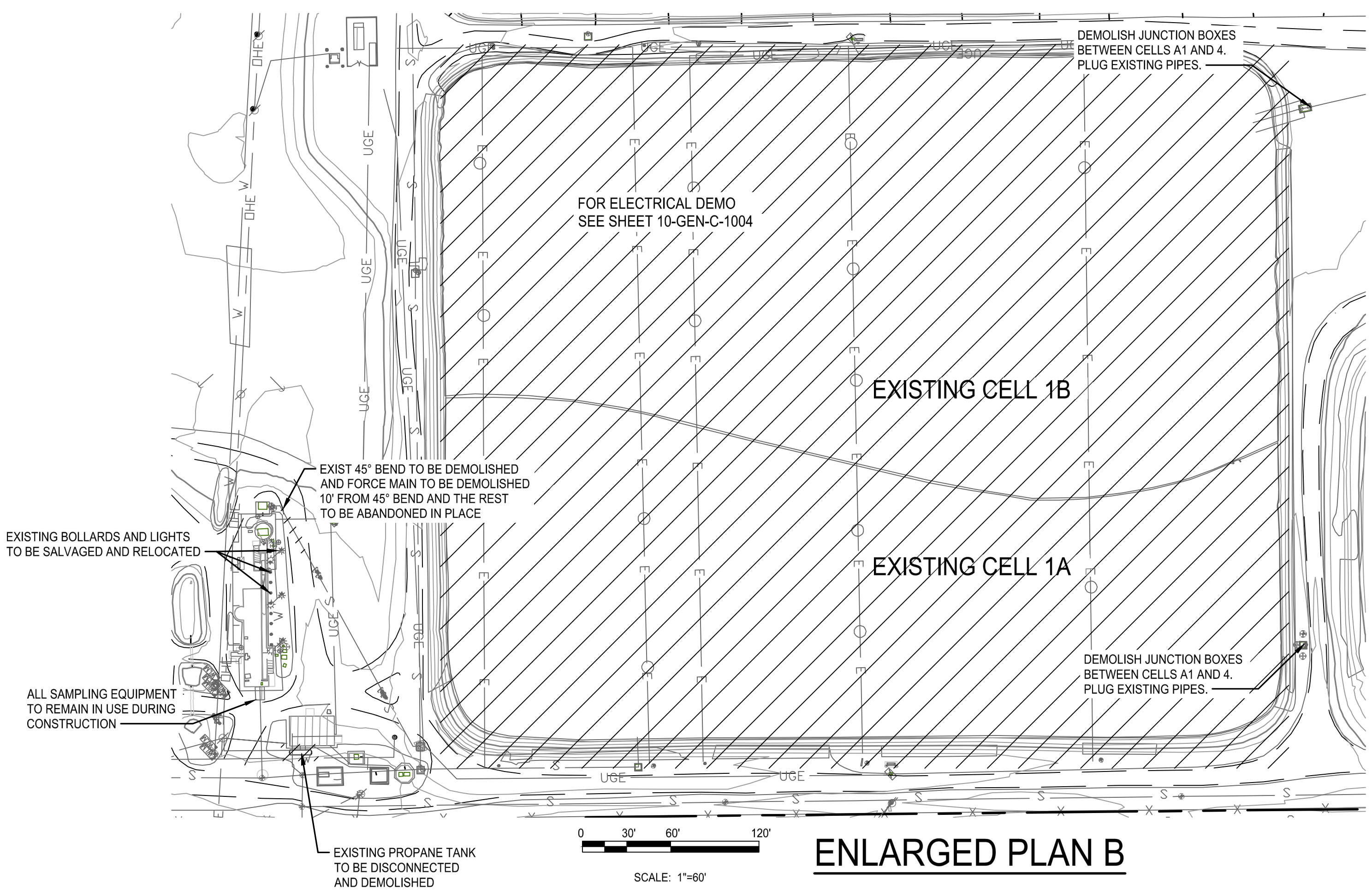
ENLARGED PLAN A

SCALE: 1"=60'



ENLARGED PLAN C

SCALE: 1"=20'



SCALE: 1"=60'

ENLARGED PLAN B

DEMOLITION NOTES:

1. CONTRACTOR TO DEMO, ABANDON, OR RELOCATE EQUIPMENT IN USE ONCE NEW PLANT IS OPERATIONAL.
2. CELL 4 WILL BE USED AS EMERGENCY STORAGE AS PART OF NEW PLANT.
3. ALL EXISTING EQUIPMENT IN CELL 1 TO BE REMOVED. THIS INCLUDES THE SUSPENDED AERATOR CABLES AND AERATORS.
4. BELOW GRADE BASINS TO BE DEMOLISHED TO 3' BELOW GRADE, HOLES TO BE DRILLED INTO BOTTOM, THEN BACKFILLED TO MATCH GRADE.
5. CONTRACTOR SHALL PROTECT THE EXISTING UNDERGROUND AND OVERHEAD UTILITIES, INCLUDING BUT NOT LIMITED TO POWER, TELEPHONE, CABLE, WATER, GAS, AND SEWER, DURING THE CONSTRUCTION. UNLESS SPECIFIED, ALL UTILITIES SHALL REMAIN IN SERVICE DURING CONSTRUCTION TO SUPPORT THE EXISTING TREATMENT PLANT. CONTRACTOR IS RESPONSIBLE TO PLAN CONSTRUCTION ACTIVITIES AND SEQUENCE SUCH THAT THERE IS MINIMUM UTILITY SHUTDOWN REQUIRED. CONTRACTOR SHALL SUBMIT SEQUENCING PLAN AND COORDINATE ANY POTENTIAL SHUTDOWNS WITH THE OWNER AND OPERATORS AT MINIMUM 48 HOURS PRIOR TO PROCEDURE.
6. CONTRACTOR SHALL NOT OPEN/CLOSE VALVES OR GATES, OR SHUTDOWN ANY EQUIPMENT THAT MIGHT IMPACT THE OPERATION WITHOUT THE OWNER AND THE OPERATOR APPROVAL.
7. CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE TO THE EXISTING UTILITIES. LOCATIONS SHOWN IN THESE PLANS ARE BASED ON HISTORIC AS BUILTS AND MIGHT BE DIFFERENT FROM ACTUAL CONDITIONS. CONTRACTOR SHALL FIELD VERIFY ALL UTILITIES WITHIN THE CONSTRUCTION BOUNDARIES. SHOULD ANY DAMAGE OCCUR TO AN EXISTING UTILITY DURING THE PROGRESS OF WORK, CONTRACTOR SHALL REPAIR THE DAMAGE AT NO ADDITIONAL COST TO THE OWNER.
8. CONTRACTOR IS RESPONSIBLE FOR RELOCATION OF THE EXISTING UTILITIES REQUIRED TO MINIMIZE DOWNTIME OF EXISTING TREATMENT FACILITIES.
9. CONTRACTOR SHALL DISCONNECT AND DEMOLISH THE EXISTING GENERATOR BUILDING. THE EXISTING GENERATOR SHALL BE SALVAGED AND TURNED OVER TO THE OWNER PER SPECIFICATION SECTION 024100. CONTRACTOR SHALL MAKE SURE THERE IS NO DISCONNECT IN THE SERVICE AND THAT THE NEW BACKUP GENERATOR IS OPERATIONAL DURING THIS ACTIVITY.
10. REMOVE THE EXISTING FENCE TO THE EXTENT SHOWN.
11. CONTRACTOR SHALL DEMOLISH THE EXISTING OVERHEAD ELECTRIC POLES AT THE END OF ALL CONSTRUCTION. ALL UTILITIES SHALL REMAIN IN SERVICE DURING THE CONSTRUCTION.
12. CONTRACTOR IS REQUIRED TO SUBMIT DETAILED MAINTENANCE OF PLANT OPERATIONS PLANS (MOPO) FOR APPROVAL BY THE OWNER AND ENGINEER.

wsp
4221 BALLOON PARK RD NE
ALBUQUERQUE, NM 87109

PROJECT:
KAYENTA WWTP IMPROVEMENTS PROJECT

NAVAJO TRIBAL UTILITY AUTHORITY

WSP PROJECT No: 2151700032

REVISIONS		
NO.	DATE	DESCRIPTION

DESIGNED BY:	DDM
DRAWN BY:	DDM
CHECKED BY:	JCB
DATE:	04NOV2022

SHEET TITLE:
DEMOLITION PLAN 1

SHEET NUMBER:	REV. #
10-GEN-C-1003	0

SHEET 10 OF 223

Attachment 2: Place holder for Sludge Mass and Volume Calculations for the Kayenta Wastewater Lagoon System (2020)

H&S Environmental, LLC.

- Performance Evaluations
- Troubleshooting & Optimization
- Hydraulics Optimization
- Training

2122 East Leland Circle   Mesa, AZ 85213   1 (480) 274-8410

June 12, 2020

Wendell Murphy
NAVAJO TRIBAL UTILITY AUTHORITY
Civil Engineering & Technical Services
P.O. Box 170
Fort Defiance AZ, 86504

RE: Report on June 2, 2020, Sludge Blanket Profiling of the Kayenta Wastewater Lagoon System

Wendell,

On June 2, 2020, personnel from H&S Environmental, L.L.C .& E.T.I. entered Cells 1-4, and Dry Cells # 1 & # 2 of Kayenta's wastewater lagoon system to determine sludge volume and mass for each treatment cell.

One hundred forty-two (142) sludge depth measurements were made along with collecting thirty-four (34) sludge core samples to produce sixteen (16) composite sludge samples. These sixteen (16) sludge samples were delivered to (Eurofins) TestAmerica in Phoenix to be analyzed for Total Percent Solids and used to estimate the sludge mass in dry tons.

Three different math models and one math formula are used in this report to derive average sludge volume and mass for each treatment cell. The following is a report on our findings.

Figure 1 & 2. Core Sampling Cell # 1 and Measuring Remaining Sludge in Dry Cell # 1 of the Kayenta Wastewater Pond System

hssenvironmental@earthlink.net   WWW.Lagoonops.com

Section 1 – Summary of Findings

Summary:

	Average Actual Measured Sludge Blanket Thickness (ft)	Average Actual Measured Water Depth (ft)	Average Depth of Remaining Water Cap (ft)	Percent of Volume Occupied by Sludge (%)	Volume of Sludge (gallons) from Model # 3
Cell # 1A	**2.36**	**11.44**	**9.08**	**20.6%**	**1,508,400**
Cell # 1B	**1.76**	**11.32**	**9.56**	**15.5%**	**1,117,503**
Cell # 2	**0.58**	**11.36**	**10.78**	**5.1%**	**884,791**
Cell # 3	**0.81**	**9.34**	**8.53**	**8.7%**	**709,243**
Cell # 4	**0.8**	**8.78**	**7.98**	**9.1%**	**617,167**
Cell # 5	**0.309**	**Dry Cell**	**Dry Cell**	**Dry Cell**	**262,032**
Cell # 6	**0.174**	**Dry Cell**	**Dry Cell**	**Dry Cell**	**163,673**

Table 1. Volume Data from Model # 3. Average Sludge Blanket Thickness and Water Depth for Each Treatment Cell. An average of twenty-three (23) Sampling Locations Were Used to Determine the Average Sludge Blanket Thickness and Average Water Depth for Each Treatment Cell

Section 2 – Calculations for Volume and Mass

Model # 1 Sludge Volume Calculations for Kayenta's Cell # 1A

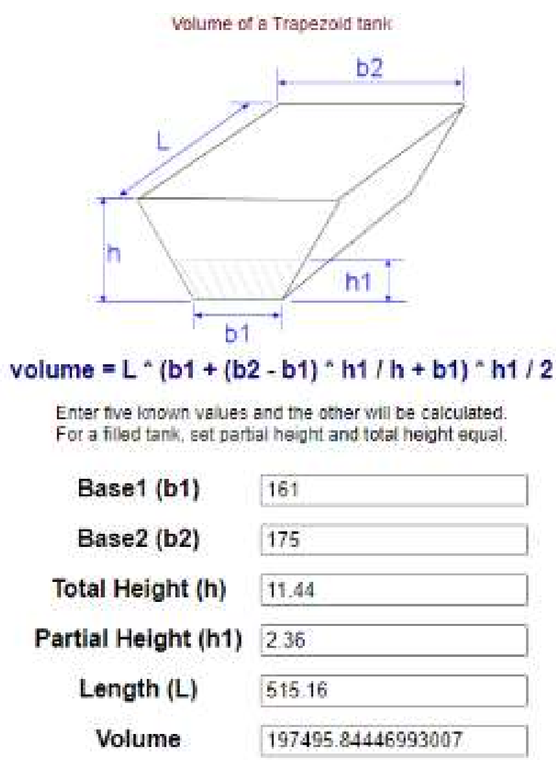


Figure 3. Model # 1 for Determining Sludge Volumes in Cells 1-4 Plus Dry Cells 1 & 2

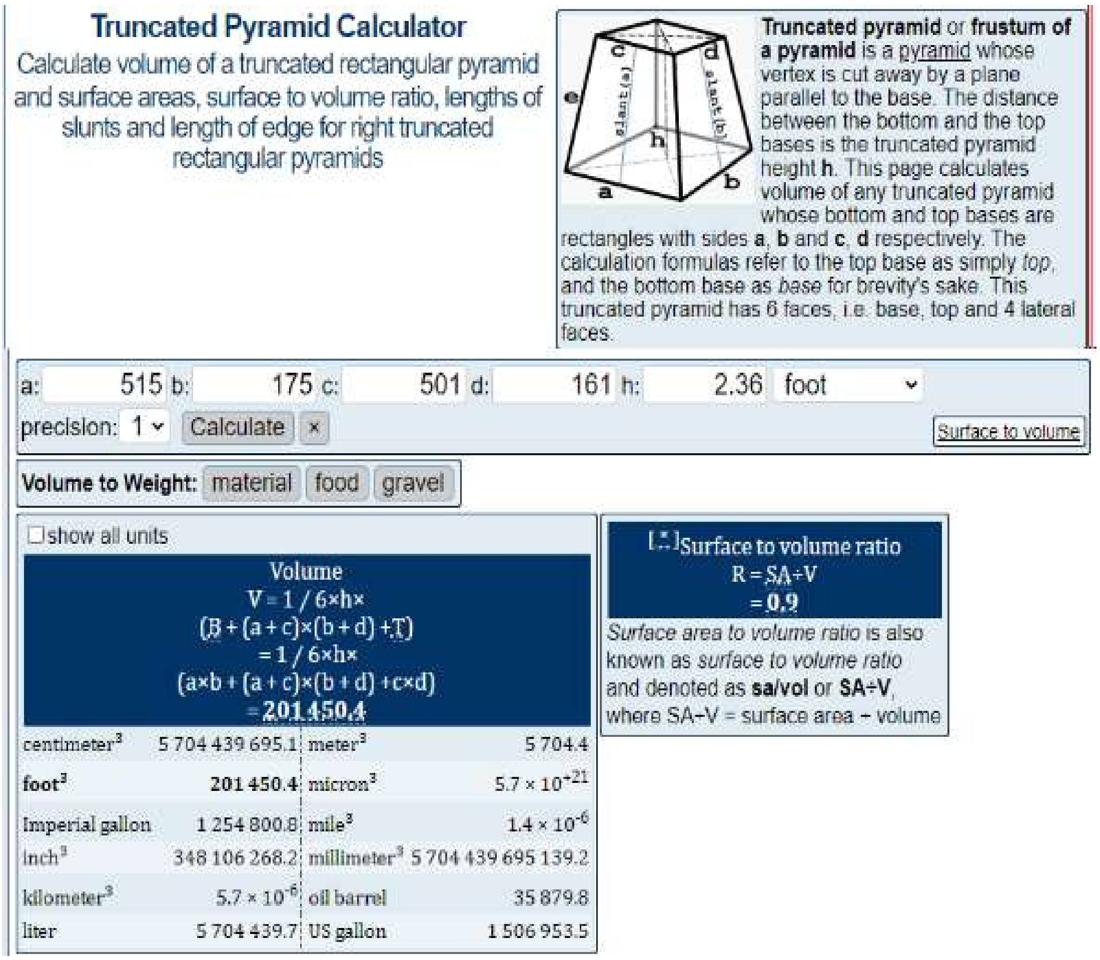
Cell # 1: 1,447,270 gallons of sludge

This model was used on Cell 1B and Cells 2-4 and Dry Cells 1 & 2 as well. The results are reported in Table 2 below.

Section 2 – Calculations for Volume and Mass

Model # 2

Using the shape of a truncated prism, with 3:1 slope the sludge volume for Cell -1A in Model # 2 calculates as follows:


Truncated Pyramid Calculator

Calculate volume of a truncated rectangular pyramid and surface areas, surface to volume ratio, lengths of slunts and length of edge for right truncated rectangular pyramids

Truncated pyramid or **frustum of a pyramid** is a pyramid whose vertex is cut away by a plane parallel to the base. The distance between the bottom and the top bases is the truncated pyramid height **h**. This page calculates volume of any truncated pyramid whose bottom and top bases are rectangles with sides **a**, **b** and **c**, **d** respectively. The calculation formulas refer to the top base as simply *top*, and the bottom base as *base* for brevity's sake. This truncated pyramid has 6 faces, i.e. base, top and 4 lateral faces.

a: 515 b: 175 c: 501 d: 161 h: 2.36 foot

precision: 1 Calculate × Surface to volume

Volume to Weight: material food gravel

show all units

Volume
V = 1 / 6×h×
(B + (a + c)×(b + d) + T)
= 1 / 6×h×
(a×b + (a + c)×(b + d) + c×d)
= 201 450.4

centimeter³	5 704 439 695.1	meter³	5 704.4
foot³	**201 450.4**	micron³	5.7 × 10⁻²¹
Imperial gallon	1 254 800.8	mile³	1.4 × 10⁻⁶
inch³	348 106 268.2	millimeter³	5 704 439 695 139.2
kilometer³	5.7 × 10⁻⁶	oil barrel	35 879.8
liter	5 704 439.7	US gallon	1 506 953.5

Surface to volume ratio
R = SA÷V
= 0.9

Surface area to volume ratio is also known as *surface to volume ratio* and denoted as **sa/vol** or **SA÷V**, where SA÷V = surface area ÷ volume

Figure 4. Model # 2 Used for Determining Sludge Volumes in Cells 1-4 plus Dry Cells 1 & 2

Total Cell # 1 Sludge Volume Using Model # 2:

1,506,954 gallons of sludge

This model was used on Cell 1B and Cells 2-4 and Dry Cells 1 & 2 as well. The results are reported in Table 2 below.

Please refer to the graphics at the end of this report for sludge blanket thickness locations throughout each treatment cell, and please note that average sludge blanket thickness and average Total Solids (%) is used to determine sludge volume and mass.

Section 2 – Calculations for Volume and Mass

Model # 3

Model # 3 Sludge Volume Calculator for Kayenta AZ , H&S Environmental, LLC									
Elevations are calculated based on measured pond depth. Eroded Slopes Exist									
Shape is rectangular with rounded edges and eroded sloped sides using									
average sludge depths									
Item	**Units**	**Cell # 1A**	**Cell # 1B**	**Cell # 2**	**Cell # 3 minus a fraction**	**Cell # 4 minus a fraction**	**Dry Cell # 1 Old Cell # 1**	**Dry Cell # 2 Old Cell # 2**	**Total**
Bottom Length	feet	**501**	**502**	**802**	**534**	**537**	**490**	**545**	
Bottom Width	feet	**161**	**162**	**252**	**434**	**380**	**230**	**230**	
Side Slopes	1 to	**3**	**3**	**3**	**3**	**3**	**3**	**3**	
Average Sludge Depth	feet	**2.36**	**1.76**	**0.58**	**0.81**	**0.8**	**0.309**	**0.174**	
As-Built Bottom Elevation	feet	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	
As-Built Top-of-Bank Elevatic	feet	**14.00**	**14.00**	**14.00**	**14.00**	**14.00**	**14.00**	**14.00**	
Bottom Area	sq ft	80,661	81,324	202,104	231,756	204,060	112,700	125,350	
Top of Sludge Length	feet	515.16	512.56	805.48	538.86	541.8	491.854	546.044	
Top of Sludge Width	feet	175.16	172.56	255.48	438.86	384.8	231.854	231.044	
Top of Sludge Area	sq ft	90,235	88,447	205,784	236,484	208,485	114,038	126,160	
Sludge Volume	cu ft	201,658	149,399	118,288	94,818	85,509	35,031	21,881	**706,584**
Sludge Volume	gallons	**1,508,400**	**1,117,503**	**884,791**	**709,243**	**617,167**	**262,032**	**163,673**	**5,262,809**
This is an estimate only. This estimate is based on badly eroded side slopes,									
a pond bottom that varies in depth, has rounded corners, veriable									
sludge blanket depths and is based on an average of 20 sample points per treatment cell									
Estimates of elivations Calculated. Pond dimensions are based on measurements from Google Earth									
Do not use this information for dredging contractor estimates									

Figure 5. Model # 3 Used to Determine Sludge Volumes in Cells 1-4 and Dry Cells # 1 & # 2

Cells 1A & B & Dry Cells 1 & 2 sludge volumes are all calculated in the same manner using three (3) math models and a math formula for calculating the volume of a rectangular frustum. The results of all three (3) models and the mathematical calculation are summarized below to give a range of sludge volume and mass. Please see the appendix for sludge thickness locations.

	Average Actual Measured Sludge Blanket Thickness (ft)	Sludge Volume from Model # 1	Sludge Volume from Model # 2	Sludge Volume from Model # 3	Sludge Volume from Mathematical Calculations	Average Estimated Sludge Volume	Average Total Solids (%)	Tons of Dry Solids
Cell # 1A	2.360	1,477,420	1,506,954	1,508,400	1,533,958	1,506,683	6.30	394
Cell # 1B	1.760	1,098,677	1,117,336	1,117,503	1,121,413	1,113,732	6.83	318
Cell # 2	0.580	880,920	876,163	884,791	877,132	879,751	3.30	118
Cell # 3	0.810	708,999	712,813	709,243	709,656	710,178	11.00	325
Cell # 4	0.800	616,603	631,422	617,167	508,763	593,489	6.35	169
Cell # 5	0.309	261,591	262,171	262,032	262,031	209,565	96.00	1049
Cell # 6	0.174	163,453	163,661	163,673	163,670	130,891	97.00	665

Table 2. A Summary of Individual Treatment Cell Sludge Volumes and the Total Sludge Volume for Wastewater Treatment Cells 1-4 and Dry Cells 1 & 2 as Calculated by Three Math Models and Mathematical Formula

Section 2 – Calculations for Volume and Mass

Supporting Formula and Calculations for Sludge Volume and Mass:

The Formula for Calculating Treatment Cell Sludge Volumes

$$\text{Sludge Volume } (ft^3) = \left[\frac{W \times L + (W-2SH) \times (L-2SH)}{2}\right] \times H$$

W = width of lagoon (ft)
L = length of lagoon (ft)
S = slope (ratio of horizontal to vertical distances on the interior sides of lagoon).
3:1, the slope is taken as 3.
H= height of liquid or depth of liquid in the lagoon. (ft)

Figure 6. Formula Used for Calculating the Sludge Volume of a Truncated Pyramid or (Rectangular Frustum)

Cell # 1A Sludge Volume Calculation:

Result: $\left[\frac{175 \times 515 + (175 - 2(3)\ (.2.36)) \times (515 - 2(3)\ (2.36))}{2}\right] \times 2.36 \times 7.48\ gal/ft^3 =$ **<u>1,533,958 gallons</u>**

Cell # 1B Sludge Volume Calculation:

Result: $\left[\frac{173 \times 513 + (173 - 2(3)\ (1.76)) \times (513 - 2(3)\ (1.76))}{2}\right] \times 1.75 \times 7.48\ gal/ft^3 =$ **<u>1,121,413 gallons</u>**

Cell # 2 Sludge Volume Calculation:

Result: $\left[\frac{256 \times 806 + (256 - 2(3)\ (0.58)) \times (806 - 2(3)\ (0.58))}{2}\right] \times 0.58 \times 7.48\ gal/ft^3 =$ **<u>887,132 gallons</u>**

Cell # 3 Sludge Volume Calculation:

Result: $\left[\left[\frac{439 \times 539 + (439 - 2(3)\ (.81)) \times (539 - 2(3)\ (.81))}{2}\right] \times .81 \times 7.48\ gal/ft^3\right] /2 =$ **<u>709,656 gallons</u>**

Cell # 4 Sludge Volume Calculation:

Result: $\left[\left[\frac{504 \times 547 + (504 - 2(3)\ (0.80)) \times (547 - 2(3)\ (0.80))}{2}\right] \times 0.80 \times 7.48\ gal/ft^3\right]/2$ Minus a triangular segment of area:308,583 gallons = **<u>508,763 gallons</u>**

Dry Cell # 1 Sludge Volume Calculation:

Result: $\left[\frac{232 \times 492 + (232 - 2(3)\ (0.309)) \times (492 - 2(3)\ (0.309))}{2}\right] \times 0.309 \times 7.48\ gal/ft^3 =$ **<u>262,276 gallons</u>**

Dry Cell # 2 Sludge Volume Calculation:

Result: $\left[\frac{231 \times 546 + (231 - 2(3)\ (0.174)) \times (546 - 2(3)\ (0.174))}{2}\right] \times 0.174 \times 7.48\ gal/ft^3 =$ **<u>163,628 gallons</u>**

Section 2 – Calculations for Volume and Mass

The Formula for Calculating Sludge Mass

Tons of Solids, Cell -1A = $\frac{201{,}658\ (ft^3) \times 7.48\ gal/ft^3 \times 8.34\ lbs./gal \times .0627\ \%\ Solids}{2{,}000\ lbs./ton}$ = **394 dry tons**

Tons of Solids, Cell -1B = $\frac{149{,}399\ (ft^3) \times 7.48\ gal/ft^3 \times 8.34\ lbs./gal \times 0.0683\ \%\ Solids}{2{,}000\ lbs./ton}$ = **318 dry tons**

Tons of Solids, Cell - 2 = $\frac{118{,}288\ (ft^3) \times 7.48\ gal/ft^3 \times 8.34\ lbs./gal \times 0.032\%\ Solids}{2000\ lbs./ton}$ = **118 dry tons**

Tons of Solids, Cell -3 = $\frac{94{,}818\ (ft^3) \times 7.48\ gal/ft^3 \times 8.34\ lbs./gal \times .110\ \%\ Solids}{2{,}000\ lbs./ton}$ = **325 dry tons**

Tons of Solids, Cell -4 = $\frac{85{,}509\ (ft^3) \times 7.48\ gal/ft^3 \times 8.34\ lbs./gal \times 0.0635\ \%\ Solids}{2{,}000\ lbs./ton}$ = **169 dry tons**

Tons Solids, Dry Cell -1 = $\frac{35{,}031\ (ft^3) \times 7.48\ gal/ft^3 \times 8.34\ lbs./gal \times 0.96\%\ Solids}{2000\ lbs./ton}$ = **1,049 dry tons**

Tons Solids, Dry Cell -2 = $\frac{21{,}881\ (ft^3) \times 7.48\ gal/ft^3 \times 8.34\ lbs./gal \times 0.97\%\ Solids}{2000\ lbs./ton}$ = **622 dry tons**

Section 2 – Calculations for Volume and Mass

Sample Name	Total Solids Result (%)
Cell-1A Composite # 1	4.2
Cell-1A Composite # 2	6.0
Cell-1A Composite # 3	8.6
Average	**6.27**
Cell-1B Composite # 1	7.2
Cell-1B Composite # 2	7.2
Cell-1B Composite # 3	6.1
Average	**6.8**
Cell -2 Composite # 1	3.1
Cell -2 Composite # 2	3.5
Average	**3.3**
Cell -3 Composite # 1	10
Cell -3 Composite # 2	12
Average	**11**
Cell -4 Composite # 1	5.9
Cell -4 Composite # 2	6.8
Average	**6.35**
Dry Cell # 1 Sample # 1	96
Dry Cell # 1 Sample # 2	96
Average	**96**
Dry Cell # 1 Sample # 1	97
Dry Cell # 1 Sample # 2	97
Average	**97**

Table 3. Summary of Core Sample Results Used to Determine the Mass of Sludge in Each Treatment Cell. Please see attached for TestAmerica Lab Results

Section 3 – Notes and Conclusions for the Calculation of Volume and Mass

NOTES

In the estimation of sludge mass, the following considerations must be made.

Because of blow sand and dirt entering the surface of each treatment cell, and grit and gravel entering the primary cells from the collection system, adjustments must be made to the estimated sludge mass. The bottom three (3) inches of the sludge at the very bottom of the sludge profile cannot be collected because of the limitations of the core sampling equipment. It must be assumed that the bottom two (2) to four (4) inches could be as dense as 30% or more Total Solids.

The core sampler for Total Solids sampling may have rested on a layer of thick, dense, impenetrable sand and dirt covering the liner, causing the underestimation of Sludge blanket thickness leading to an underestimation of the sludge mass and volume.
.
It is prudent to add a two (2) to four (4) inch volume factor and a twenty (20) or thirty (30) % mass factors for accumulated dirt, sand, and grit that could not be collected for Total Solids analysis.

Model and Measurement Limitations

Averages were used in the calculations. Elevation estimates were used, but actual water and sludge thickness were measured and used. The treatment cells are irregular in shape and have rounded corners. Slopes are affected by years of erosion and not true 3:1 slopes.

In some cases where the grit, gravel, and sand are thick, the survey level rod for measuring the waster depths may have rested on top of the sand grit and gravel blanket, causing an underestimation of volume and mass.

The top of the sludge blanket may vary in density due to gas activity in the blanket. This is important because we measure sludge blanket thickness. The density of the upper few centimeters of the sludge blanket varies seasonally with gas production and bioactivity. An average TS lab result was used to determine dry tons of sludge. There is some variation in density from one end of each treatment cell to the other.

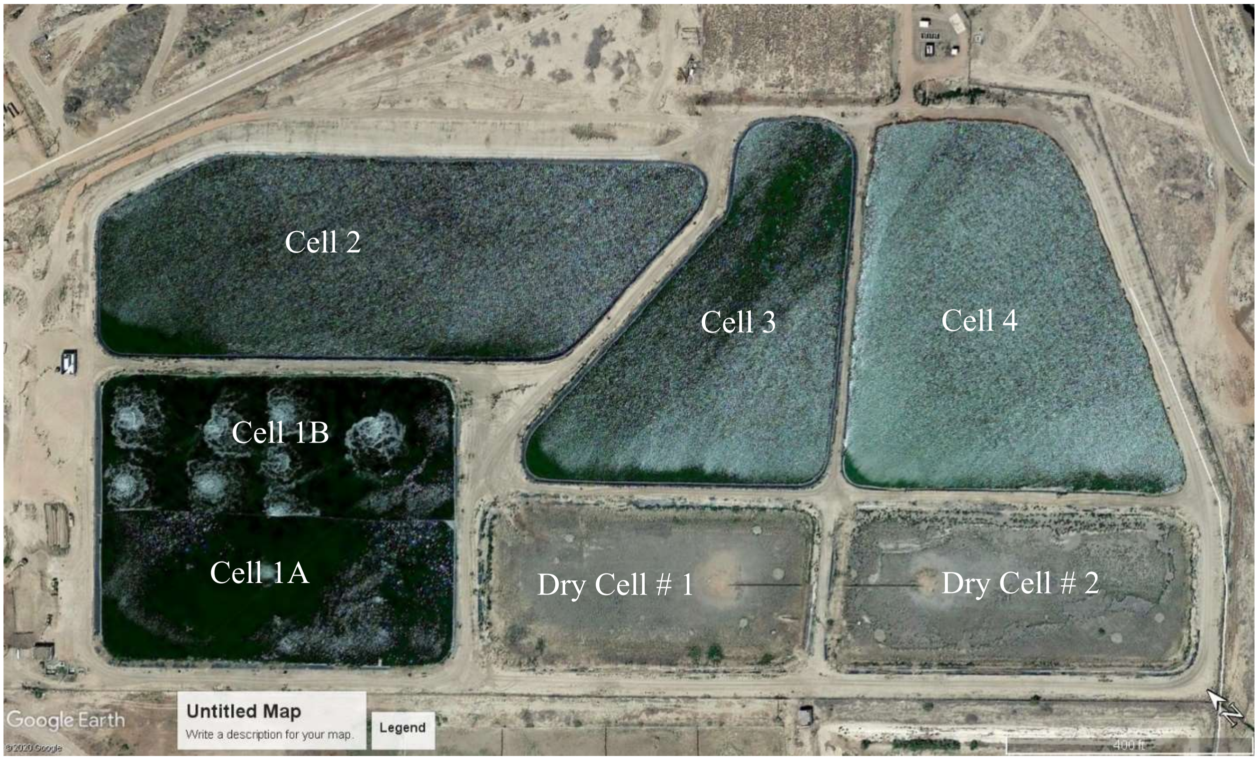
Thank you for the opportunity to serve the good people of the NTUA

Sincerely,

Steve Harris
President
H&S Environmental, L.L.C.

Appendix

The Kayenta Wastewater Lagoon System. Two Dry Cells and four active treatment cells



Appendix Figure 1. Satellite View of the Kayenta Wastewater Lagoon System

Cell #1A Sludge Blanket Thickness Locations

N

	1	2	3	4	5	6	7	8	9
A	4.00	1.50	1.33	1.25	1.50	1.58	0.83	1.67	4.33
B	3.50	3.83	3.00	1.00	1.75	2.67	0.33	2.17	4.25
C	1.92	4.08	2.50	1.67	2.00	1.83	1.08	4.00	4.08

Cell # 1B Sludge Blanket Thickness Locations

N ↑

	1	2	3	4	5	6	7	8
A	1.42	1.67	0.75	0.50	1.08	2.08	1.33	3.50
B	0.67	1.83	0.50	1.00	2.17	0.83	2.00	3.75
C	0.50	0.67	1.00	0.83	2.75	3.33	3.83	4.17

Cell # 2 Sludge Blanket Thickness Locations

N ↑

	1	2	3	4	5	6
A	0.58	0.50	0.25	0.58	0.58	0.33
B	0.50	0.58	0.75	0.42	0.33	0.67
C	0.58	0.75	0.75	0.83	0.92	

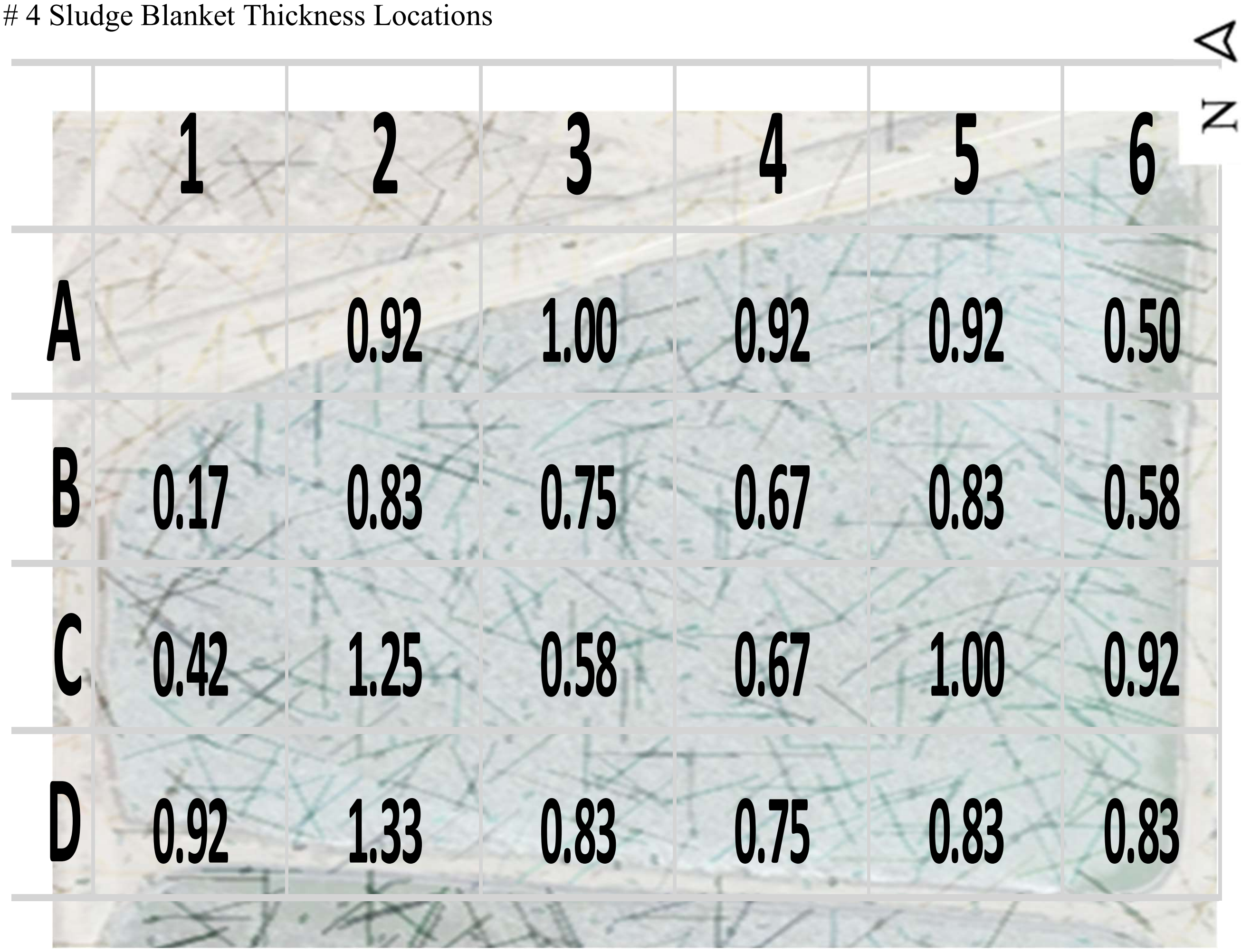
hssenvironmental@earthlink.net WWW.Lagoonops.com

N

Cell # 3 Sludge Blanket Thickness Locations

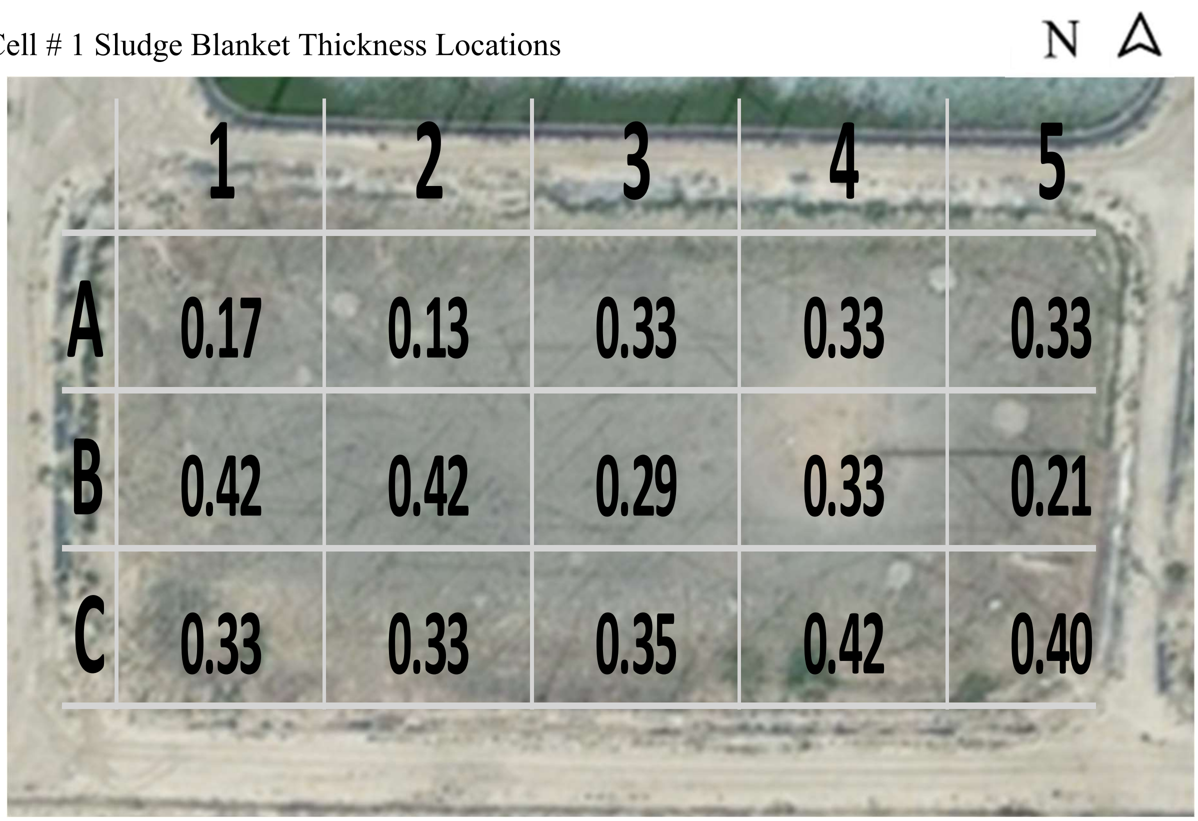
	1	2	3	4	5
A	0.50	0.75	1.00	1.08	0.92
B	0.67	0.42	0.67	0.83	1.08
C		0.50	0.92	0.75	1.08
D			0.92	0.92	0.83
E				0.75	0.75
F					0.92

Cell # 4 Sludge Blanket Thickness Locations



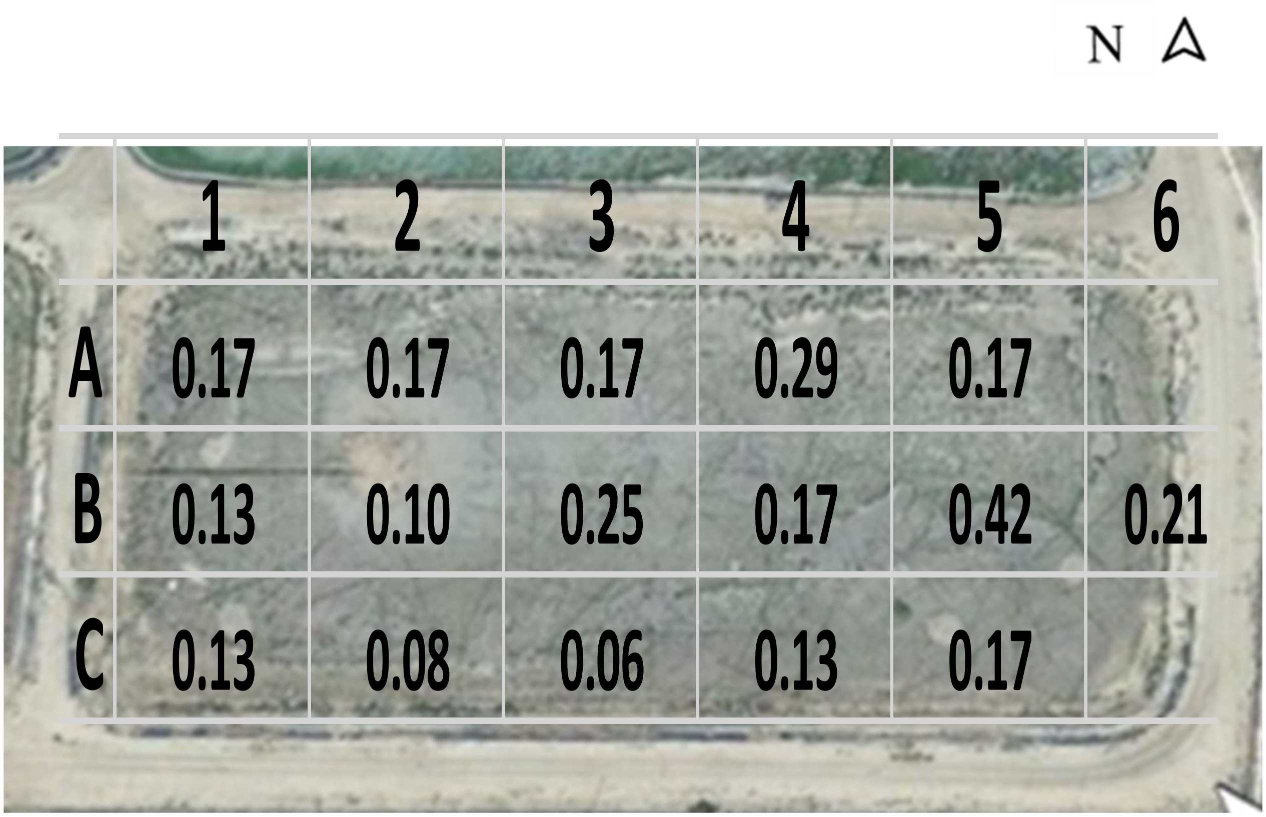
	1	2	3	4	5	6
A		0.92	1.00	0.92	0.92	0.50
B	0.17	0.83	0.75	0.67	0.83	0.58
C	0.42	1.25	0.58	0.67	1.00	0.92
D	0.92	1.33	0.83	0.75	0.83	0.83

Dry Cell # 1 Sludge Blanket Thickness Locations



	1	2	3	4	5
A	0.17	0.13	0.33	0.33	0.33
B	0.42	0.42	0.29	0.33	0.21
C	0.33	0.33	0.35	0.42	0.40

Dry Cell # 2 Sludge blanket Thickness Locations



hssenvironmental@earthlink.net WWW.Lagoonops.com