



# MARBLE-ARNO STORM DRAINAGE DESIGN

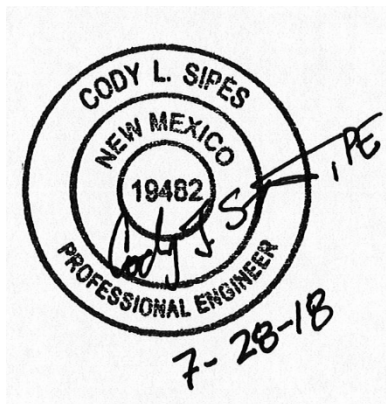
CONCEPTUAL DESIGN STUDY

CITY OF ALBUQUERQUE

**FINAL**

JULY 28, 2018

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal as a professional engineer licensed to practice in the state of New Mexico, is affixed below.



Cody Sipes, NMPE 19482

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## INTRODUCTION

Smith Engineering Company (Smith) entered into an agreement with the City of Albuquerque (COA) on April 16, 2018 to complete the design of the Marble-Arno Storm Drainage Design Project. This project is intended to alleviate flooding that occurs at the Lomas-Broadway intersection, and will replace the aging N. Broadway Pump Station. As part of its design, Smith is to determine the size of the detention facility, the size of the discharge pumps, determine the site configuration and coordinate with power utilities for power supply to the site. Previous studies completed for the current site include 'Final Conceptual Design Report for Marble-Arno Stormwater Pump Station, a Replacement for Broadway Pump Station', by Molzen Corbin in 2013, and the Mid-Valley Drainage Master Plan by Smith in 2012 which initially recommended the current project. However, that report analyzed a separate set of design criteria than what is being used for the current project. The South Broadway Drainage Master Plan was completed by URS in 2012 and indicates that the existing site would be impacted by external surface inflows.

Now that it is the intent that the N. Broadway Booster Station be abandoned, Smith proposed that a brief analysis be completed routing various sized detention ponds with different outlet pumping rates to determine if reduced construction costs may be achieved. The analysis and the design direction Smith is proposing is summarized in the following:

## PROCEDURE/DATA COLLECTION

The following items were considered to determine the design direction:

- Runoff volumes and flow rates were computed from a Hydrologic Analysis
- Site restrictions, available ponding area, and facility layout
- Routing of stormwater inflows to the detention facility, with varying pond sizes and outflow options.
- Pumping requirements, size and equipment costs
- Forcemain alignments, size and discharge points
- Structural analysis of vertical detention pond wall options
- Primary power supply alternatives
- Backup power supply alternatives
- Constructability and estimated construction costs

## HYDROLOGIC ANALYSIS

Smith utilized the Stormwater Management Model (SWMM) that was completed for the Mid-Valley Drainage Plan for the COA and modified it to include the contributing stormwater discharges from the South Broadway watershed identified in the URS study from 2012. The SWMM was additionally modified not to account for other proposed projects identified in the Mid-Valley Drainage Plan. Smith routed these flows into the SWMM, and then determined the inflow hydrograph to the pond. A second SWMM was completed that omitted the contributing stormwater discharges from the URS study and it was found that this made a significant change to the size of the Marble-Arno facility. Smith had previously reviewed the study by URS and found several conservative and redundant assumptions that contributed to the high discharge into the Lomas-Broadway area. As such, Smith met



with the COA and AMAFCA to discuss the impact of this offsite flows on this project. Considering recent drainage improvement projects implemented in the South Broadway watershed, future drainage projects planned, and the very conservative assumptions made in the URS study, COA directed Smith to omit the inflows from the South Broadway watershed from the design of the new facility.

## HYDRAULIC ANALYSIS

The rate of discharge from the detention facility routed with the inflow into the facility determines the amount of storage required in the detention facility. The Lomas-Broadway area is in a depressed area so discharge from the detention facility must be accomplished by pumping. The existing North Broadway lift station utilizes a 54-inch forcemain which eventually discharges into the North Diversion Channel. This discharge location is approximately 165 feet higher than the site location, which is a lot of static head for the discharge pumps to overcome. This head will increase based on the depth of the detention pond, and the level of the water within the pond. Another discharge location option is to the 72-inch storm drain facility that runs west on Lomas Blvd. from the intersection of Broadway and Lomas. A set of smaller pumps in the existing station currently discharge to this location through a 10-inch forcemain. These pumps are for small nuisance flows and for emptying the detention facility. Record drawings for the 10-inch forcemain could not be found, but GIS data indicates that it is PVC. For the purposes of this study, it is assumed that the forcemain is C-900 PVC material. This discharge point is at a slightly lower elevation than the project site but is limited in the amount of additional stormwater it can receive. The Mid-Valley DMP SWMM was used to determine that this storm drain system can receive up to a maximum of 15 cfs.



**Figure 1: Existing Discharge to the North Diversion Channel**

As discharge rates increase, the horsepower requirement of the pumps increase. Pumps exceeding 500 hp should be medium voltage (e.g. 2,400V or 4,160V). Power (to be discussed in depth later) for a medium voltage service may be more expensive. As such, Smith investigated pumping options that would have pumps under 500 hp, and pumps in the medium voltage range. Discharge to the Lomas storm drain would also significantly reduce the horsepower of the pumps because of the reduced amount of static head that is required. The discharge options considered by Smith were the following:

Option#1: A 60 cfs low voltage, pump station consisting of five 12 cfs pumps, and one 1.5 cfs sump pump. The sump pump would discharge to the Lomas storm drain and the remaining five pumps would discharge to the N. Diversion Channel. This option was selected because pumps with capacities larger than 12 cfs were required to be medium voltage pumps. A peak flow of 60 cfs also provides a velocity of 3.5 ft/s in the 54-inch forcemain which is recommended to resuspend settled solids in the forcemain.

Option #2: An 80 cfs, medium voltage pump station consisting of one 1.5 cfs sump pump discharging to the storm drain on Lomas. Two 15 cfs pumps and two 25 cfs pumps would discharge to the N. Diversion Channel. Alternatively, five 16 cfs pumps with the sump pump may be used in this option. At this flow rate the velocity in

the 54-inch forcemain will be approximately 5 ft/s which should provide the self-cleaning during peak operation while minimizing excessive pressure surges during sudden pump start or stops.

Option #3: A 130 cfs, medium voltage pump station consisting of one 1.5 cfs sump pump and five 26 cfs pumps. The 26 cfs pumps would discharge to the N. Diversion Channel, and the 1.5 cfs pump would discharge to the Lomas-Broadway intersection using the existing 10-inch forcemain. This is the flow rate that was analyzed in the Molzen Report and is similar to the existing 150 cfs capacity of the N. Broadway Pump Station. The velocity in the 54-inch forcemain at this flow rate is approximately 8.4 ft/s which should be considered the maximum practical velocity.

Smith completed a Water Cad model of the pumping facility and developed forcemain system curves. Smith researched information on the existing piping from the North Broadway Pump Station. Record drawings did not indicate the type of pipe used in the 54-inch forcemain to the North Diversion Channel. The Molzen-Corbin Report indicated that the forcemain was constructed from concrete cylinder pipe. Operating personnel have indicated that they believe the pipe is steel. As part of the preliminary design, Smith will coordinate an inspection of the pipe to ascertain the material type. To estimate the power requirements for the pumps, Smith conservatively estimated that the pipe was constructed with steel.

The COA and its operating staff have indicated that the preferred type of pump for the station are Flygt submersible pumps. These pumps are used throughout the city in stormwater pumping stations and sanitary lift stations. Smith used the Flygt pump selection tool to select pump station configurations. The pump selection tool provided pump curve operating points, full load power requirements, and dimensional information. Smith used the pump curve operating points in its Water Cad model and used the dimensional information to complete a preliminary sizing of a pump wet-well in accordance with ANSI/HI 9.8-2018. The new forcemain piping required to connect to existing forcemains was assumed to be ductile iron pipe with a cement mortar lining.

Several iterations of site grading, system curve calculations, and pumps selections were required to obtain suitable hydraulic results for the conceptual design. Smith started with a conceptual layout that provided an estimated footprint of area available and then completed grading of the pond to various depths and slopes to obtain stage-storage relationships. Based on the volume of the inflow hydrograph, initial storage volumes were estimated. System curves were then developed for the forcemains, and then pumps were selected using an online tool for Flygt pumps. The discharges for the pumps were then inserted in the stage-storage table based on the pumps at 1-foot depth intervals. The pumps did not start discharging until there was adequate suction head for the pumps to operate without cavitating. The revised storage amount was determined, system curves were then updated, and the pumps were re-selected until this iterative process was completed to provide results for each option that are suitable for the conceptual design and the selection of an alternative.

## SITE CONFIGURATION

Conceptual site layouts were based on the maximizing the ponding area, while trying to allocate sufficient area for pumping facilities, electrical power equipment, access for maintenance equipment, and for aesthetic and landscape elements. Additional items considered in the site layout were ingress and egress to the site, functional design of piping, access into the pond, construction, and security of the facilities.



The site configurations are based on the following parameters:

- A 50' x 30' (1500 SF) building footprint would house the electrical control equipment for pump station.
- The site fencing/Façade could be installed along the property lines against adjoining properties.
- The site fencing/Façade would have a 10-foot offset from the property line along Broadway Blvd., and five-foot offset from the property lines along Arno and Marble streets.
- Area for stormwater detention was maximized.
- A 50' X 40' area is needed for electrical utility equipment, or generators.
- A 2.5H to 1V side slope was used as a conservative estimate of slope stability requirements for unlined ponds.
- A 1.5H to 1V side slope was used as a maximum slope for concrete lined ponds.
- Access for medium trucks and cranes must be provided for maintenance of pumps and electrical equipment.
- Ingress and egress to the site should be from roads with less traffic density to allow time for the opening and closing of gates.
- Recessed entries were not considered because these areas attract nefarious activity.
- A pump wet-well, separate from the detention pond is required to allow for trash screening prior to pumping.

## STRUCTURAL ANALYSIS

The limited area for the pond will require that ponds requiring larger storage capacities have vertical walls. Various types of vertical walls were considered, but two types were ultimately compared for various depths. Two pond wall heights were selected to be analyzed based on initial pond routing calculations. The heights analyzed were 25 ft, 18 ft, and an additional 30 ft wall was analyzed which may be used for the wet-well structure. The two types of walls considered were concrete secant pile walls and cantilever retaining walls. Since soil investigations were being completed concurrently with the conceptual design, the in-situ soil recommendations from the Geotechnical Engineer were not available and had to be assumed. The following assumptions were made for the design of the walls:

- Soil in-situ density is 110 lbs/ft<sup>3</sup>
- Active soil pressure is 1/3 the soil density
- Passive soil pressure is three (3) times the soil density
- Equivalent fluid pressure
- Soil friction resistance for sliding is 0.4.
- 2,000 psf soil bearing capacity
- 4,000 psi concrete will be used
- A surcharge loading of 100 psf was added for use of maintenance equipment along the walls
- Cantilever retaining walls assumed that adequate drainage material/systems could be installed
- Secant pile walls were calculated with and without hydrostatic pressure in case the in-situ material does not readily drain.

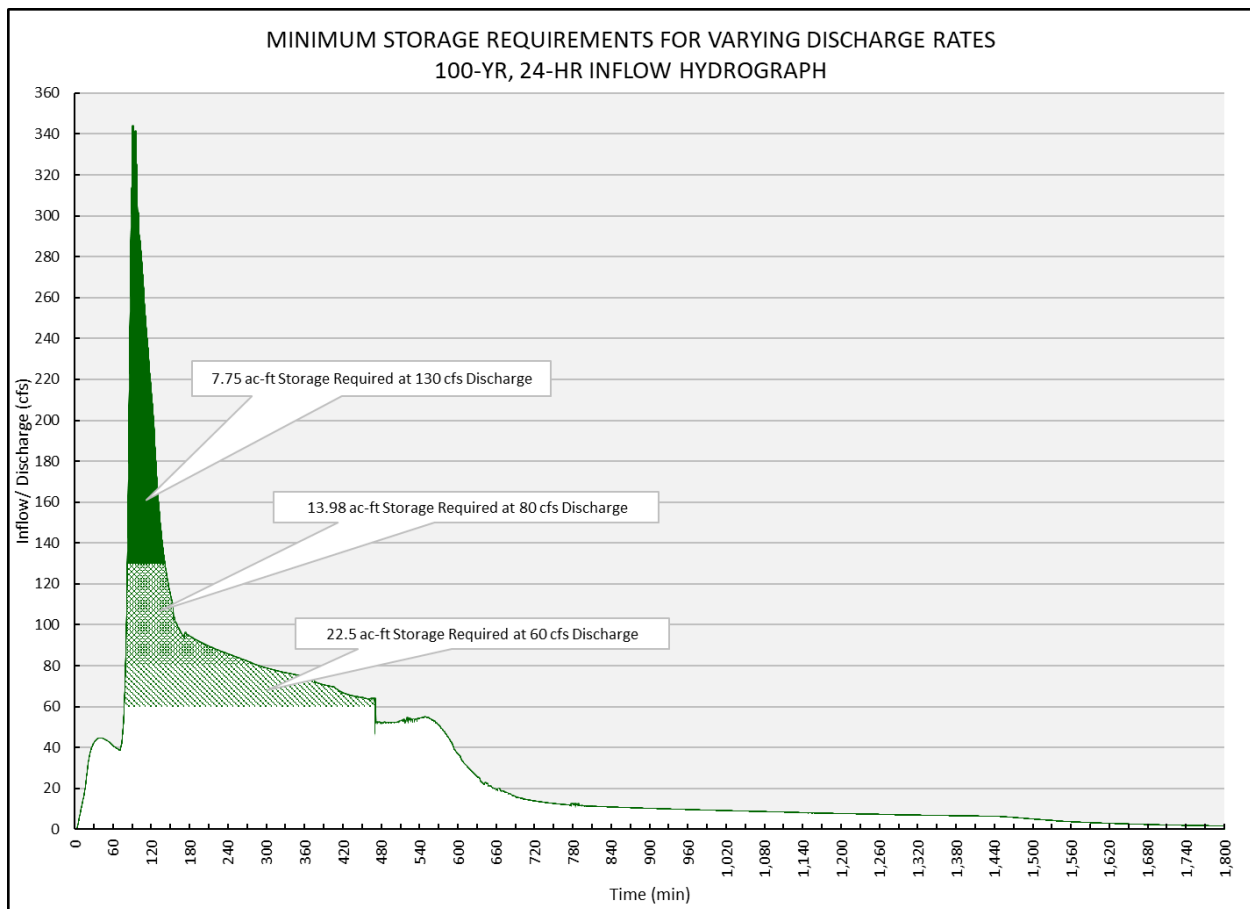
## FINDINGS

### HYDROLOGIC RESULTS

The inflow hydrograph to the pond is shown in **Figure 2** below. The peak inflow is 344 cfs occurring 91 minutes into the runoff event. 81-acre feet of runoff enters the facility during the storm event. **Figure 2** also shows the minimum storage requirements at the three selected discharge rates.

These storage capacities are minimum because it would assume an instantaneous discharge by the pumps and would not account for the lag time of the pumps starting at different water elevations within the facility. Routed storage capacities required for the ponds are shown in the following Hydraulic Results section of this report.

In addition, the SWMM model indicated that an additional 15 cfs could be placed into the storm drain on Lomas Blvd. to the west of Broadway. This available capacity is the maximum amount that may be pumped from the new facility by the low flow pumps and transmission line.



**Figure 2- Detention Pond Inlet Hydrograph and Minimum Storage Requirements**



## HYDRAULIC RESULTS

Smith developed system curves for each of the existing forcemains. Depending on the level within the detention pond, the system curve shifts vertically based on the depth of water within the storage facility.

**Figure 3** on page 7 shows the system curve for the existing 10-inch forcemain with the detention pond full (which is the same for all options) and for an empty detention facility. The depth for an empty facility shown is based on Option 1, which is the lowest pumping rate resulting in the deepest pond. The other options have empty detention pond system curves within the boundaries of the curves shown in **Figure 3**. The 10-inch PVC forcemain quickly increases head as flow increases. Another system curve was calculated for the 54-inch forcemain and is shown in **Figure 4** on page 8. This figure also shows a range which was determined in the same manner as the 10-inch forcemain.

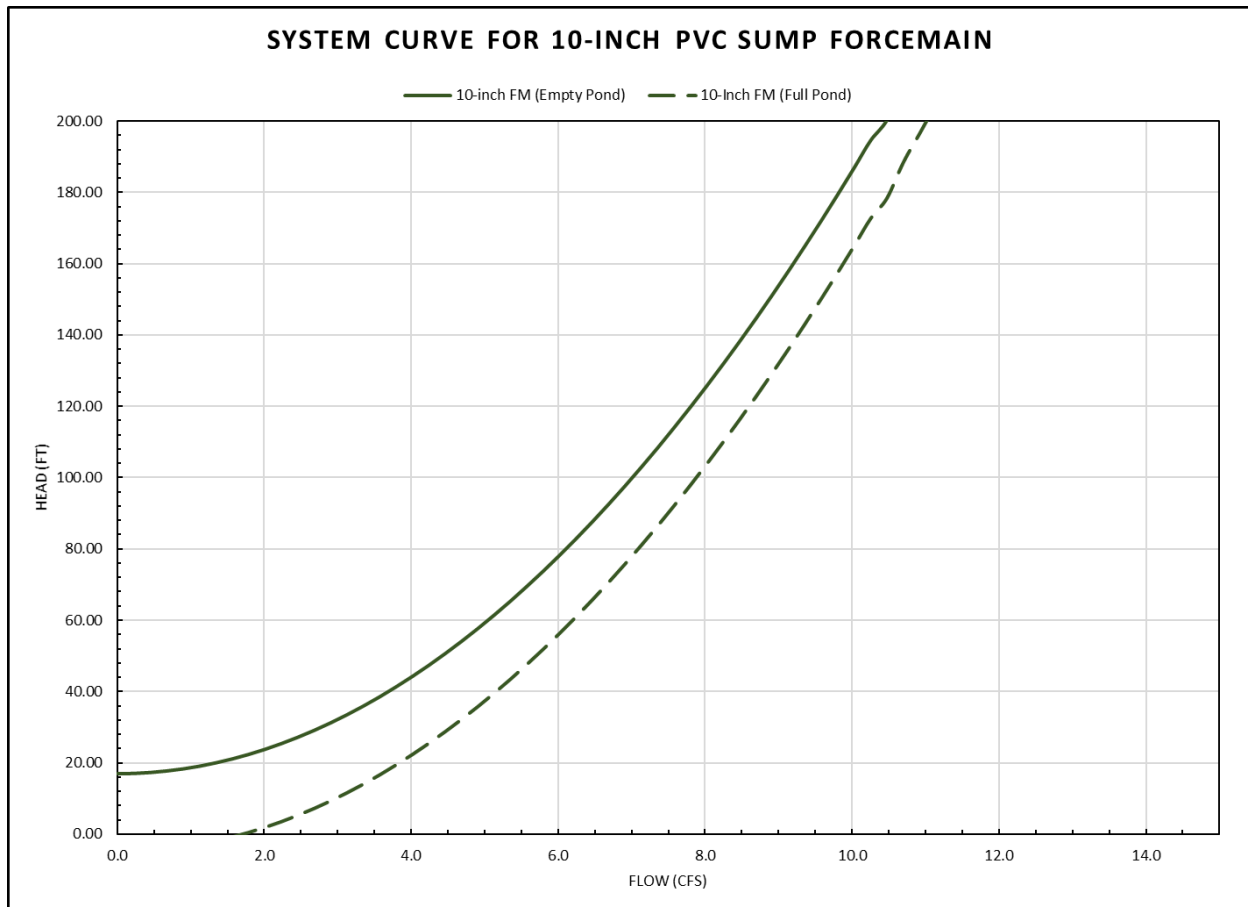
Smith performed routing calculations for the three options which are detailed in the appendices. Each pond grading option and the structural wall type yielded different stage storage relationships which changes the routing of the pond. **Table 1** includes a summary of the results for each routed option and alternative. It was assumed for the purposes of all these options that the wet-well would be three feet deeper than the pond to provide additional head for the pump suction. The 26 cfs pumps however require that approximately 8-feet of head be provided over the suction of the pump. That is why the larger pumps do not turn on until there is 5-feet of water in the pond, and why the sump pumps take up to 33 hours to empty the pond (Option 3A). The depth of the wet-well can be increased to alleviate the amount of time to pump out the pond and to further reduce pond capacity. This should be considered during the design of the wet-well and pump selection.

**Table 1: Summary of Parameters for Options**

Option	Detention Pond Description	Storage Required (AC-FT)	Storage Available (AC-FT)	Depth (FT)	Outflow (cfs)
Option 1A:	Vertical Concrete Cantilever Walls	25.7	26.2	26	60
Option 1B:	Vertical Concrete Secant Pile Walls	26.0	27.0	24	60
Option 2A:	Vertical Concrete Cantilever Walls	17.9	18.3	18	80
Option 2B:	Vertical Concrete Secant Pile Walls	18.2	19.3	17	80
Option 2C:	1.5H to 1V Sloped Concrete Lined Walls	15.9	16.7	20	80
Option 3A:	Vertical Concrete Cantilever Walls	13.3	13.3	13	130
Option 3B:	2.5H to 1V Sloped Rock Plated Walls	11.0	11.0	14	130

Smith estimated footprints required for the pump wet-well based on the design requirements of ANSI/HI 9.8-2018. Wet-wells for a pump station of this size, containing solids bearing material shall either be the rectangular style or trench type. Inlet piping to the wet-well shall have a minimum length of eight pipe diameters of straight pipe to obtain straight flowlines prior to entering the wet-well. A trench style wet-well is shown in the site layouts as it will offer the smallest footprint and provides less maintenance. Trench style wet-wells are designed with an ogee spillway transition at the inlet which converts potential energy to kinetic energy during pump down of the wet-well which effectively moves sediment and debris down along the sloped floor of the wet-well. In addition, the wet-well shall be 2-5 feet deeper than the pond to provide additional suction head over the pumps. The larger pumps will require that larger suction heads be available, and this will allow the larger pumps to drain the detention pond to a lower level reducing the detention time and sump pump operation. Smith will coordinate the wet-well design

with the pump manufacturer. Flygt pumps also have a design option which provides for a smaller wet-well than the conventional method of the rectangular or trench style. The conventional rectangular option was considered, but due to its large footprint requirement it was not selected. Additional consulting with the pump manufacturer may result in reconfiguration of the wet-well as the design continues.



**Figure 3- System Curve for 10-Inch PVC Forcemain to Lomas-Broadway Intersection**

Smith also completed a proposed layout of a header pipe for the pump discharge. This layout was completed using flanged ductile iron fittings and piping. The size of the fittings dictate the size of the header pipe in the layouts shown. Smith will complete the design of a welded steel header pipe which will allow for custom pipe connections and may reduce the size of structure required to house the discharge header and valves. The discharge header will be adequately coated and lined to reduce the rate of corrosion. The discharge piping for each pump will contain a check valve and isolation valve. Smith will coordinate with the City and operating personnel to ensure that valve operators are installed that may be serviced and operated by their personnel. In addition, Smith is proposing that surge relief valves be installed to allow surge pressures to discharge back into the pond, and that a drain line and valve be installed to allow the forcemain to be drained back into the pond.

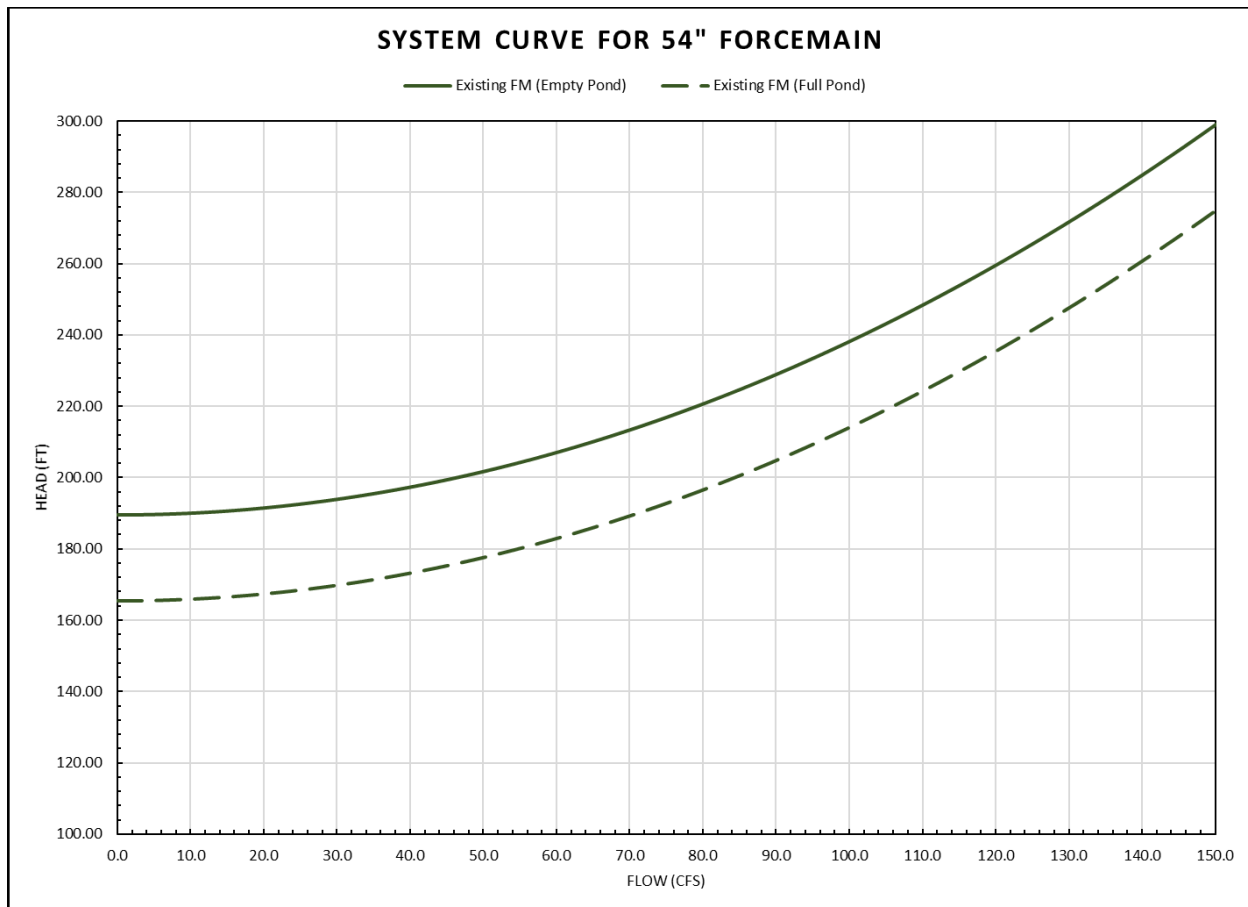


Figure 4: System Curve for 54" Forcemain to North Diversion Channel

## STRUCTURAL RESULTS

The structural wall sections for the various types of walls at different depths are shown in **Appendix D**. It was found that the cantilever wall resulted in smaller wall section in terms of cubic yards of concrete per lineal foot of wall but has additional constructability concerns. The construction of cantilever walls would require that over excavation be completed and construction shoring would need to be installed. To allow room for the construction shoring, the footprint of cantilever walls was reduced which resulted in deeper ponds for these options. Secant pile walls could be installed without excavation and would provide the construction shoring for the excavation of the pond. The use of vertical walls or secant pile walls adds a significant cost to the construction of the pond. It was assumed for the costs of the secant pile wall, that the additional depth to resist hydrostatic forces was not required. This cannot be ascertained until the geotechnical investigation is completed, and could further increase the cost of the drilled secant pile walls.

Structural design will be completed in accordance to applicable codes and standards, including the International Building Code 2015 Edition (IBC 2015), which requires that special inspections be completed during various stages of the work. This includes concrete placement, which requires continuous inspection of subgrade placement, and concrete placement by qualified personnel. As such, cantilever wall construction would require additional construction observation than the secant pile walls (assuming the excavation, subgrade prep, and concrete

placement would be a longer duration than drilling the piles) which could contribute to longer construction times and increased professional costs.

## POWER SUPPLY

Smith analyzed the power requirements and cost for the three pump station flow options. Option #1 = 60 CFS, Option #2 = 80 CFS and Option #3 = 130 CFS. Obviously, the larger the flow rate, the larger the pumps and larger electrical service and equipment costs.

Due to the maximum 480V transformer size offered by PNM, the utility service voltage must be 12kV, even for Option #1. 12kV must be transformed to a lower voltage to be used to power pumps and other electrical equipment such as the mechanical bar screen, HVAC, lighting and receptacles. The large pumps in Options #2 and #3 require 2,400 or 4,160V power. The pumps in Option #1, nuisance water pump and mechanical bar screen require 480V power. HVAC, lighting, receptacles, RTU cabinet and other incidental loads will require 120 or 208V power.

Power for the existing pump station is provided from a 49kV distribution line. A large oil-filled distribution transformer located at the pump station reduces the voltage from 49kV to 4160V. PNM indicated that they do not own this transformer. The transformer needs maintenance and is probably reaching the end of its useful service life. This 49kV distribution line and transformer also provides backup power for the ABCWUA sanitary lift station #6.

The 49kV transmission line may be a source of power for the new pump station. But, since 49kV is no longer a nominal voltage for PNM, it is unlikely. PNM will not provide a 49kV to 4,160V transformer. Therefore, if the new pump station must be fed from the existing 49kV transmission line, the City would have to provide a 49kV to 4160V transformer. Distribution type transformers of this voltage are costly and have a long lead time.

Another option for utilizing the existing 49kV distribution line would be to run 4,160V secondary power from the existing transformer to the new pump station. This has some additional safety risks for utility owners who may be excavating within the rights of way of Broadway Boulevard in the future. To lessen these risks, the 4,160V secondary feeders would need to be concrete encased. Using the existing transformer should only be considered as a temporary source because of its age and condition. The City would also have to maintain the existing transformer in the future.

The new pump station requires a backup power supply so that the pumps remain operational in event of a utility power failure. Two backup power options were evaluated. Each option was evaluated for cost using one of the two following backup power options. Therefore, single line diagrams, load calculations and opinions of probable cost were generated and evaluated for all three pumping options with each backup power option.

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### BACKUP POWER OPTION 1 (DUAL ELECTRICAL SERVICES FROM UTILITY)

For this option to be a viable solution, each utility service must be derived from a separate utility grid/substation. That way, if utility power is lost in one grid, it is unlikely that power will be lost in the other grid at the same time. This is the preferred backup power option.



There are existing 12kV overhead power lines running north-south on Broadway Boulevard and Arno Street. Unfortunately, both power lines are served by the Arno Substation. Therefore, only one of these two overhead power lines can be used to provide one of the two electrical services. However, PNM has another overhead power line running east-west just north of the post office, which is being served from their Lomas Substation. It may be possible for PNM to extend this power line to provide the pump station with the second electrical service. PNM is currently in the process of determining whether these existing power lines have the capacity for serving the new pump station loads, as well as the cost for installation.

Assuming PNM can provide two separate 12kV electrical services to the pump station from two separate substations, PNM will install an automatic transfer switch on site to automatically switch from one power source to the other if one of the feeders loses power. From this automatic transfer switch, 12kV power would be metered and transformed down to power the pump station as indicated in the attached Dual Service One Line Diagram Exhibits in **Appendix E**.

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## BACKUP POWER OPTION 2 (STANDBY GENERATORS)

If it is cost prohibitive for PNM to provide two separate 12kV services to the site, backup power for the pumps will be provided by engine-driven standby generators. Diesel engine-driven generators with automatic transfer switches would be required to provide enough power to operate all pumps in the event of a utility power failure.

Natural gas engine-driven generators were considered, but they cost between 2 and 3 times the cost of a diesel engine generator at the size required for this pump station. See attached Single Service One Line Diagram Exhibits in **Appendix E**.

Diesel engine generators required for each pumping option range from \$400k to \$1M. Besides the up-front capital cost, generators require refueling, service, maintenance and weekly operation (exercising). During operation, large generators like this will produce a lot of noise unless more money is spent to attenuate the noise.

## INSTRUMENTATION AND CONTROLS

The pump station will be monitored and controlled by an Allen-Bradley CompactLogix programmable logic controller (PLC). The PLC cabinet will include an operator interface terminal (OIT) for local monitoring and control of the pump station. The PLC will monitor level in the wet-well using two Drexelbrook continuous level transmitters for redundancy. As water level in the wet-well rises, logic in the PLC will start and stop pumps as necessary to empty the wet-well.

A high-level alarm float switch will be provided to activate an alarm if pumps do not operate or cannot keep up with stormwater flow entering the wet-well.

Pumps will be controlled by solid state reduced voltage soft starters to provide a ramped start and ramped stop to limit water hammer and voltage flicker on neighbors when motors are started. Reduced voltage starters also allow smaller generators to be installed because the initial inrush current is reduced.



## SCADA

The PLC will be connected to a Motorola radio for communication with the SCADA master located at the wastewater treatment plant. The existing radio antenna will be relocated to the new pump station and will be installed on the exterior of the new electrical building or an antenna mast.

Signals such as pump running, pump in auto, pump failure, motor overtemperature, high level alarm, utility power failure, intrusion, etc. will be transmitted to the SCADA master via radio for remote monitoring and alarm notification. If standby generators are provided for backup power, signals from each generator and transfer switch such as generator running, generator malfunction, generator fuel level, generator door open, transfer switch position, etc. will also be transmitted to the SCADA master.

## ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COSTS

Preliminary cost estimates were performed with a 30% contingency for the three pumping discharge options, and the various detention pond construction alternatives. **Table 2** summarizes the key parameters of the distinct options along with the total cost. Detailed quantities and costs tables are presented in **Appendices A, B, and C**.

Smith Engineering Company, and it's subconsultant has been working with the electrical utility provider (PNM) to determine if power is available for the construction of the station. At the time of the completion of this report, PNM was unable to provide confirmation that dual service is available, and the estimated costs for extending the service to the site. As such, the estimated costs budget for electrical are based on the costs of providing electrical generators which should be more expensive then extending electrical service to the site. If for some reason, it is more expensive to extend the power to the site, then the generators become the viable alternative.

**Table 2: Summary of Engineer's Opinion of Probable Construction Costs**

Option	Detention Pond Description	Subtotal	Contingencies	NMGRT	Total
Option 1A:	Vertical Concrete Cantilever Walls	\$12,944,300	\$3,883,290	\$1,325,173	\$18,200,000
Option 1B:	Vertical Concrete Secant Pile Walls	\$14,496,800	\$4,349,040	\$1,484,110	\$20,300,000
Option 2A:	Vertical Concrete Cantilever Walls	\$13,406,800	\$4,022,040	\$1,372,521	\$18,800,000
Option 2B:	Vertical Concrete Secant Pile Walls	\$14,521,300	\$4,356,390	\$1,486,618	\$20,400,000
<b>Option 2C:</b>	<b>1.5H to 1V Sloped Concrete Lined Walls</b>	<b>\$11,178,550</b>	<b>\$3,353,565</b>	<b>\$1,144,404</b>	<b>\$15,700,000</b>
Option 3A:	Vertical Concrete Cantilever Walls	\$14,886,300	\$4,465,890	\$1,523,985	\$20,900,000
Option 3B:	2.5H to 1V Sloped Rock Plated Walls	\$13,020,800	\$3,906,240	\$1,333,004	\$18,300,000

## CONCLUSIONS/RECOMMENDATIONS

After performing a comprehensive analysis of the options, it appears that Option 2C will be the cheapest at \$15.7 million. By utilizing a 1.5H to 1V sloped concrete lined walls, it mitigates most of the constructability issues associated with vertical wall construction in a congested downtown area. This option also provides a balance between the pond storage volume and pump discharge rate and provides for better hydraulics in the pumping system. The 80 cfs pumping rate ensures adequate velocity with the forcemain but will not have excessive velocities which may lead to scouring of linings and high surge pressures.

The second lowest construction cost option is the 130 cfs pump station with sloped walls (Option 3B). In addition to its higher construction costs, this option will have higher operation costs; will require more standby power; will not perform as good hydraulically; has higher mechanical component replacement costs; and may not have a detention facility with adequate depth (in its current design state) to catch the storm flows coming from the north on Broadway. The remaining options seem to be cost prohibitive in comparison.

Smith recommends and intends on proceeding with the Option 2C and will start moving forward upon receipt of concurrence from the City. Additional storage, or pumping capacities can be provided as conservative measures should the City desire, but this may affect the overall construction costs. In addition, Smith will continue to work with the pump manufacturer to determine if there is a better pump selection alternative that may reduce pumping, piping, and electrical costs.

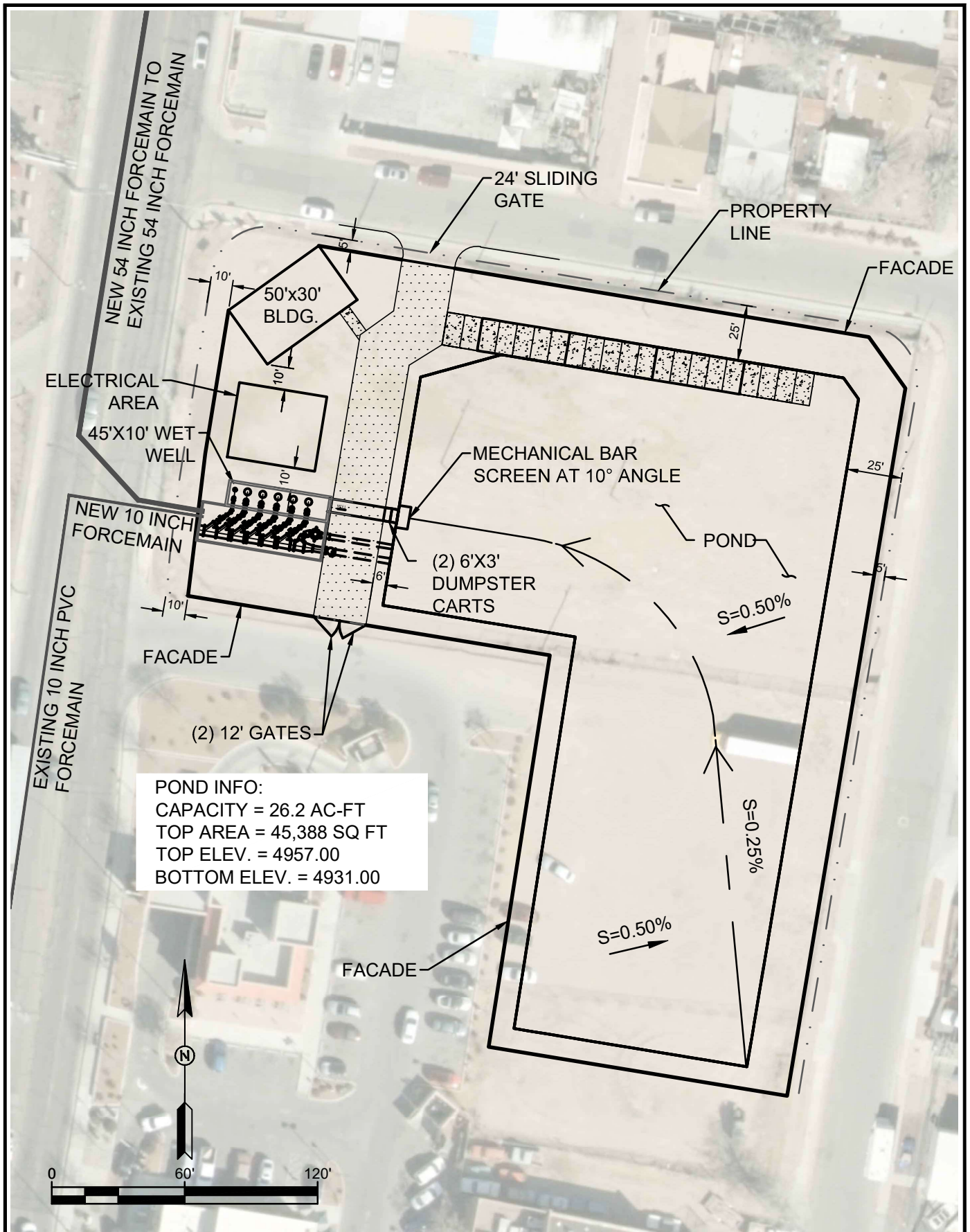


## APPENDIX A: OPTION 1- 60 CFS PUMP STATION ALTERNATIVES

Appendix A contains the conceptual layouts, opinion of costs, and pond routing summary considered for the 60 cfs pump station option.







Solutions for Today...  
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Building 4, Suite 200  
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# MARBLE ARNO STORM DRAINAGE DESIGN CONCEPTUAL DESIGN STUDY

OPTION 1A: 60 CFS DISCHARGE WITH CANTILEVER WALLS

JOB NO:  
118102

DATE:  
JULY 2018

SHEET NO:  
A-1

## Engineers Opinion of Probable Construction Costs

## Marble-Arno Storm Drainage Design Option #1A: 60 cfs Discharge and Detention Pond with Cantilever Walls

Item #	Bid Item	Description	Unit	Quantity	Unit Cost	Total
1	4.010	Construction Staking, Complete	LS	1	\$40,000.00	\$40,000.00
2	6.010	Construction Project Sign, per Contract special provisions	EA	2	\$700.00	\$1,400.00
3	6.050	Construction Mobilization/ Demobilization, Complete.	%	7.0%	\$742,000.00	\$742,000.00
4	19.010	Temporary Traffic Control and Barricading, Complete.	LS	1	\$100,000.00	\$100,000.00
5	201.010	Site Clearing, Grubbing, and removal and disposal of obstructions, complete	LS	1	\$150,000.00	\$150,000.00
6	201.060	Temporary Erosion and Sediment Control, complete.	LS	1	\$20,000.00	\$20,000.00
7	205.012	Haul of Excess Material from site, complete.	CY	43000	\$15.00	\$645,000.00
8	207.019	Sanitary, water and storm drain lines, Fill with lean fill, complete.	CY	500	\$120.00	\$60,000.00
9	204.010	Excavate Unclassified Material, complete	CY	43000	\$10.00	\$430,000.00
10	301.020	Subgrade Prep. 12" at 95% compaction, complete in place.	SY	7700	\$3.00	\$23,100.00
11	302.010	Aggregate Base Course, crushed, 6" at 95% compaction, complete in place. Standard Drawing 2408	SY	7700	\$7.00	\$53,900.00
12	336.024	Furnish and place asphalt concrete, 3" thick, Superpave per Standard Specification section 336, complete and in place.	SY	3800	\$25.00	\$95,000.00
13	336.025	Furnish and place asphalt concrete, 2- 3.5" lifts, Superpave per Standard Specification section 336, complete and in place.	SY	3900	\$35.00	\$136,500.00
14	340.010	Sidewalk, 4" thick, Portland Cement Concrete, incl. subgrade compaction, complete in place. SD 2430	SY	2100	\$50.00	\$105,000.00
15	340.030	Wheelchair Access Ramp, 4" PCC, Std. Curb., complete in place. SD 2418	EA	18	\$2,500.00	\$45,000.00
16	340.050	Curb & Gutter, Standard, Portland Cement Concrete, incl. subgrade preparation, complete in place. SD 2415	LF	2800	\$20.00	\$56,000.00
17	343.030	Existing Pavement, Asphalt Concrete, more than 4" thick, sawcut, remove & dispose, complete.	SY	7200	\$9.00	\$64,800.00
18	343.080	Existing Curb & Gutter or Valley Gutter, PC Concrete, remove & dispose, complete.	LF	2800	\$6.00	\$16,800.00
19	343.085	Existing sidewalk, 4" PC Concrete, remove and dispose	SY	2100	\$8.00	\$16,800.00
20	550.070	Furnish and install coated steel railing, Standard Specification 550, complete.	LF	1250	\$50.00	\$62,500.00
21	440.001	Reflectorized Painted Marking, 4" width, cip.	LF	2750	\$1.00	\$2,750.00
22	410.040	Existing Chain Link Fence, remove and salvage, complete	LF	1400	\$3.00	\$4,200.00
23	510.110	Structural Reinforced Concrete including formwork, complete in place.	CY	4750	\$650.00	\$3,087,500.00
24	701.110	Trenching, Backfilling, & Compaction, for 18" to 36" sewer pipe, over 8' to 12' in depth, pipe not incl., complete	LF	700	\$27.00	\$18,900.00
25	701.210	Trenching, Backfilling, & Compaction, over 60" sewer pipe, 12' to 16' in depth, pipe not incl., complete	LF	1850	\$48.00	\$88,800.00
26	801.002	6" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$25.00	\$2,500.00
27	801.004	10" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$35.00	\$3,500.00
28	801.015	54" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill, to 6' depth, cip.	LF	700	\$300.00	\$210,000.00
29	801.059	Non-pressurized Connection to existing waterline, all sizes, incl. fittings, complete	EA	2	\$20,000.00	\$40,000.00
30	801.067	Ductile Iron MJ Fittings, Class 250, including jointing material, complete in place.	LB	17000	\$4.00	\$68,000.00
31	801.081	6" Gate Valve, cip. SD 2333	EA	1	\$1,000.00	\$1,000.00
32	801.113	Fire Hydrant, 4' bury, MJ, incl. blocking & aggregate, cip. SD 2340	EA	1	\$3,500.00	\$3,500.00
33	802.500	Water Meter Box, 3/4" to 1", incl. concrete pad, cover & lid, cip., SD 2366	EA	1	\$700.00	\$700.00
34	802.600	3/4" Water Service Line, new single connection to existing watermain, cip.	EA	1	\$650.00	\$650.00
35	910.009	24" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	700	\$45.00	\$31,500.00
36	910.027	66" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	1850	\$220.00	\$407,000.00
37	910.105	Drainline Removal, greater than 48", excl. trenching, complete	LF	1500	\$60.00	\$90,000.00
38	915.020	Catch Basin, Type "A", Double Grate, complete in place. Standard Drawing 2201	EA	25	\$3,500.00	\$87,500.00

39	920.220	Manhole, 8' dia. Type "C" or "E", 10' to 14' deep, cip. SD2101	EA	10	\$11,000.00	\$110,000.00
40		Site Piping	LS	1	\$200,000.00	\$200,000.00
41		Pumps	LS	1	\$825,000.00	\$825,000.00
42		Building	SF	1500	\$150.00	\$225,000.00
43		Site gates	LS	1	\$20,000.00	\$20,000.00
44		Façade	SF	15000	\$15.00	\$225,000.00
45		Valve Vault Fittings and Header pipe, complete in place.	LS	1	\$475,000.00	\$475,000.00
46		Grading and Compaction	SY	8500	\$5.00	\$42,500.00
47		Barscreen	LS	1	\$250,000.00	\$250,000.00
48		HVAC	LS	1	\$50,000.00	\$50,000.00
49		Landscaping	LS	1	\$100,000.00	\$100,000.00
50		Electrical Equipment, complete in place.	LS	1	\$810,000.00	\$810,000.00
51		Electrical Utility or Generator Budget	LS	1	\$700,000.00	\$700,000.00
52		Utility Relocation	ALLOW	1	\$300,000.00	\$300,000.00
53		Temporary Construction Shoring	LF	1250	\$1,200.00	\$1,500,000.00
54		Start-up and Training	LS	1	\$100,000.00	\$100,000.00

Subtotal	\$12,944,300.00
Contingencies @30%	\$3,883,290.00
Gross Receipts Tax @7.875%	\$1,325,172.71
<b>Total</b>	<b>\$18,200,000</b>





## Engineers Opinion of Probable Construction Costs

## Marble-Arno Storm Drainage Design Option #1B: 60 cfs Discharge and Detention Pond with Secant Pile Walls

Item #	Bid Item	Description	Unit	Quantity	Unit Cost	Total
1	4.010	Construction Staking, Complete	LS	1	\$40,000.00	\$40,000.00
2	6.010	Construction Project Sign, per Contract special provisions	EA	2	\$700.00	\$1,400.00
3	6.050	Construction Mobilization/ Demobilization, Complete.	%	7.0%	\$929,000.00	\$929,000.00
4	19.010	Temporary Traffic Control and Barricading, Complete.	LS	1	\$100,000.00	\$100,000.00
5	201.010	Site Clearing, Grubbing, and removal and disposal of obstructions, complete	LS	1	\$150,000.00	\$150,000.00
6	201.060	Temporary Erosion and Sediment Control, Complete.	LS	1	\$20,000.00	\$20,000.00
7	205.012	Haul of Excess Material from site, complete.	CY	44000	\$15.00	\$660,000.00
8	207.019	Sanitary, water and storm drain lines, Fill with lean fill, complete.	CY	500	\$120.00	\$60,000.00
9	204.010	Excavate Unclassified Material, complete	CY	44000	\$10.00	\$440,000.00
10	301.020	Subgrade Prep. 12" at 95% compaction, complete in place.	SY	7700	\$3.00	\$23,100.00
11	302.010	Aggregate Base Course, crushed, 6" at 95% compaction, complete in place. Standard Drawing 2408	SY	7700	\$7.00	\$53,900.00
12	336.024	Furnish and place asphalt concrete, 3" thick, Superpave per Standard Specification section 336, complete and in place.	SY	3800	\$25.00	\$95,000.00
13	336.025	Furnish and place asphalt concrete, 2- 3.5" lifts, Superpave per Standard Specification section 336, complete and in place.	SY	3900	\$35.00	\$136,500.00
14	340.010	Sidewalk, 4" thick, Portland Cement Concrete, incl. subgrade compaction, complete in place. SD 2430	SY	2100	\$50.00	\$105,000.00
15	340.030	Wheelchair Access Ramp, 4" PCC, Std. Curb., complete in place. SD 2418	EA	18	\$2,500.00	\$45,000.00
16	340.050	Curb & Gutter, Standard, Portland Cement Concrete, incl. subgrade preparation, complete in place. SD 2415	LF	2800	\$20.00	\$56,000.00
17	343.030	Existing Pavement, Asphalt Concrete, more than 4" thick, sawcut, remove & dispose, complete.	SY	7200	\$9.00	\$64,800.00
18	343.080	Existing Curb & Gutter or Valley Gutter, PC Concrete, remove & dispose, complete.	LF	2800	\$6.00	\$16,800.00
19	343.085	Existing sidewalk, 4" PC Concrete, remove and dispose	SY	2100	\$8.00	\$16,800.00
20	550.070	Furnish and install coated steel railing, Standard Specification 550, complete.	LF	1300	\$50.00	\$65,000.00
21	440.001	Reflectorized Painted Marking, 4" width, cip.	LF	2750	\$1.00	\$2,750.00
22	410.040	Existing Chain Link Fence, remove and salvage, complete	LF	1400	\$3.00	\$4,200.00
23	510.110	Structural Reinforced Concrete including formwork, complete in place.	CY	840	\$650.00	\$546,000.00
24	520.048	Drilled concrete secant pile, including concrete and reinforcing steel, 48" diameter, complete in place.	VF	12300	\$425.00	\$5,227,500.00
25	701.110	Trenching, Backfilling, & Compaction, for 18" to 36" sewer pipe, over 8' to 12' in depth, pipe not incl., complete	LF	700	\$27.00	\$18,900.00
26	701.210	Trenching, Backfilling, & Compaction, over 60" sewer pipe, 12' to 16' in depth, pipe not incl., complete	LF	1850	\$48.00	\$88,800.00
27	801.002	6" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$25.00	\$2,500.00
28	801.004	10" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$35.00	\$3,500.00
29	801.015	54" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill, to 6' depth, cip.	LF	690	\$300.00	\$207,000.00
30	801.059	Non-pressurized Connection, existing waterline, all sizes, incl. fittings, complete	EA	2	\$1,500.00	\$3,000.00
31	801.067	Ductile Iron MJ Fittings, Class 250, 36" to 54", including jointing material, complete in place.	LB	17000	\$4.00	\$68,000.00
32	801.081	6" Gate Valve, cip. SD 2333	EA	1	\$1,000.00	\$1,000.00
33	801.113	Fire Hydrant, 4' bury, MJ, incl. blocking & aggregate, cip. SD 2340	EA	1	\$3,500.00	\$3,500.00
34	802.500	Water Meter Box, 3/4" to 1", incl. concrete pad, cover & lid, cip., SD 2366	EA	1	\$700.00	\$700.00
35	802.600	3/4" Water Service Line, new single connection to existing watermain, cip.	EA	1	\$650.00	\$650.00
36	910.009	24" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	700	\$45.00	\$31,500.00
37	910.027	66" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	1850	\$220.00	\$407,000.00
38	910.105	Drainline Removal, greater than 48", excl. trenching, complete	LF	1500	\$60.00	\$90,000.00

39	915.020	Catch Basin, Type "A", Double Grate, complete in place. Standard Drawing 2201	EA	25	\$3,500.00	\$87,500.00
40	920.220	Manhole, 8' dia. Type "C" or "E", 10' to 14' deep, cip. SD2101	EA	10	\$11,000.00	\$110,000.00
41		Site Piping	LS	1	\$200,000.00	\$200,000.00
42		Pumps	LS	1	\$825,000.00	\$825,000.00
43		Building	SF	1500	\$150.00	\$225,000.00
44		Site gates	LS	1	\$20,000.00	\$20,000.00
45		Façade	SF	15000	\$15.00	\$225,000.00
46		Valve Vault Fittings and Header pipe, complete in place.	LS	1	\$475,000.00	\$475,000.00
47		Grading and Compaction	SY	8500	\$5.00	\$42,500.00
48		Barscreen	LS	1	\$250,000.00	\$250,000.00
49		HVAC	LS	1	\$50,000.00	\$50,000.00
50		Landscaping	LS	1	\$100,000.00	\$100,000.00
51		Electrical Equipment, complete in place.	LS	1	\$810,000.00	\$810,000.00
52		Electrical Utility or Generator Budget	LS	1	\$700,000.00	\$700,000.00
53		Utility Relocation	ALLOW	1	\$300,000.00	\$300,000.00
54		Temporary Construction Shoring	LF	160	\$1,200.00	\$192,000.00
55		Start-up and Training	LS	1	\$100,000.00	\$100,000.00

Subtotal	\$14,496,800.00
Contingencies @30%	\$4,349,040.00
Gross Receipts Tax @7.875%	\$1,484,109.90
<b>Total</b>	<b>\$20,300,000</b>



POND DATA				PUMP OUTFLOW							
Volume (AC-FT)	Contour Elevation	Depth (FT)	Area (FT²)	Pump#1 (CFS)	Pump#2 (CFS)	Pump#3 (CFS)	Pump#4 (CFS)	Pump#5 (CFS)	Pump#6 (CFS)	Pump #7 (CFS)	Total Outflow (CFS)
0.0	4933	0	47392	0	0	0	0	0	0	0	0
1.1	4934	1	47514	1.5	0	0	0	0	0	0	1.5
2.2	4935	2	47636	1.5	12	0	0	0	0	0	13.5
3.3	4936	3	47758	1.5	12	12	0	0	0	0	25.5
4.4	4937	4	47881	1.5	12	12	12	0	0	0	37.5
5.5	4938	5	48004	1.5	12	12	12	12	0	0	49.5
6.6	4939	6	48127	1.5	12	12	12	12	12	0	61.5
7.7	4940	7	48250	1.5	12	12	12	12	12	0	61.5
8.8	4941	8	48373	1.5	12	12	12	12	12	0	61.5
9.9	4942	9	48496	1.5	12	12	12	12	12	0	61.5
11.1	4943	10	48619	1.5	12	12	12	12	12	0	61.5
12.2	4944	11	48743	1.5	12	12	12	12	12	0	61.5
13.3	4945	12	48866	1.5	12	12	12	12	12	0	61.5
14.4	4946	13	48989	0	12	12	12	12	12	0	60
15.5	4947	14	49112	0	12	12	12	12	12	0	60
16.7	4948	15	49236	0	12	12	12	12	12	0	60
17.8	4949	16	49359	0	12	12	12	12	12	0	60
18.9	4950	17	49482	0	12	12	12	12	12	0	60
20.1	4951	18	49606	0	12	12	12	12	12	0	60
21.2	4952	19	49730	0	12	12	12	12	12	0	60
22.4	4953	20	49853	0	12	12	12	12	12	0	60
23.5	4954	21	49977	0	12	12	12	12	12	0	60
24.7	4955	22	50102	0	12	12	12	12	12	0	60
25.8	4956	23	50226	0	12	12	12	12	12	0	60
27.0	4957	24	50356	0	12	12	12	12	12	0	60
26.0 Acre Feet Storage Required				9 Hours for sump pump to empty pond							



## APPENDIX B: OPTION 2- 80 CFS PUMP STATION ALTERNATIVES

Appendix B contains the conceptual layouts, opinion of costs, and pond routing summary considered for the 80 cfs pump station option.





## Engineers Opinion of Probable Construction Costs

## Marble-Arno Storm Drainage Design Option #2A: 80 cfs Discharge and Detention Pond with Cantilever Walls

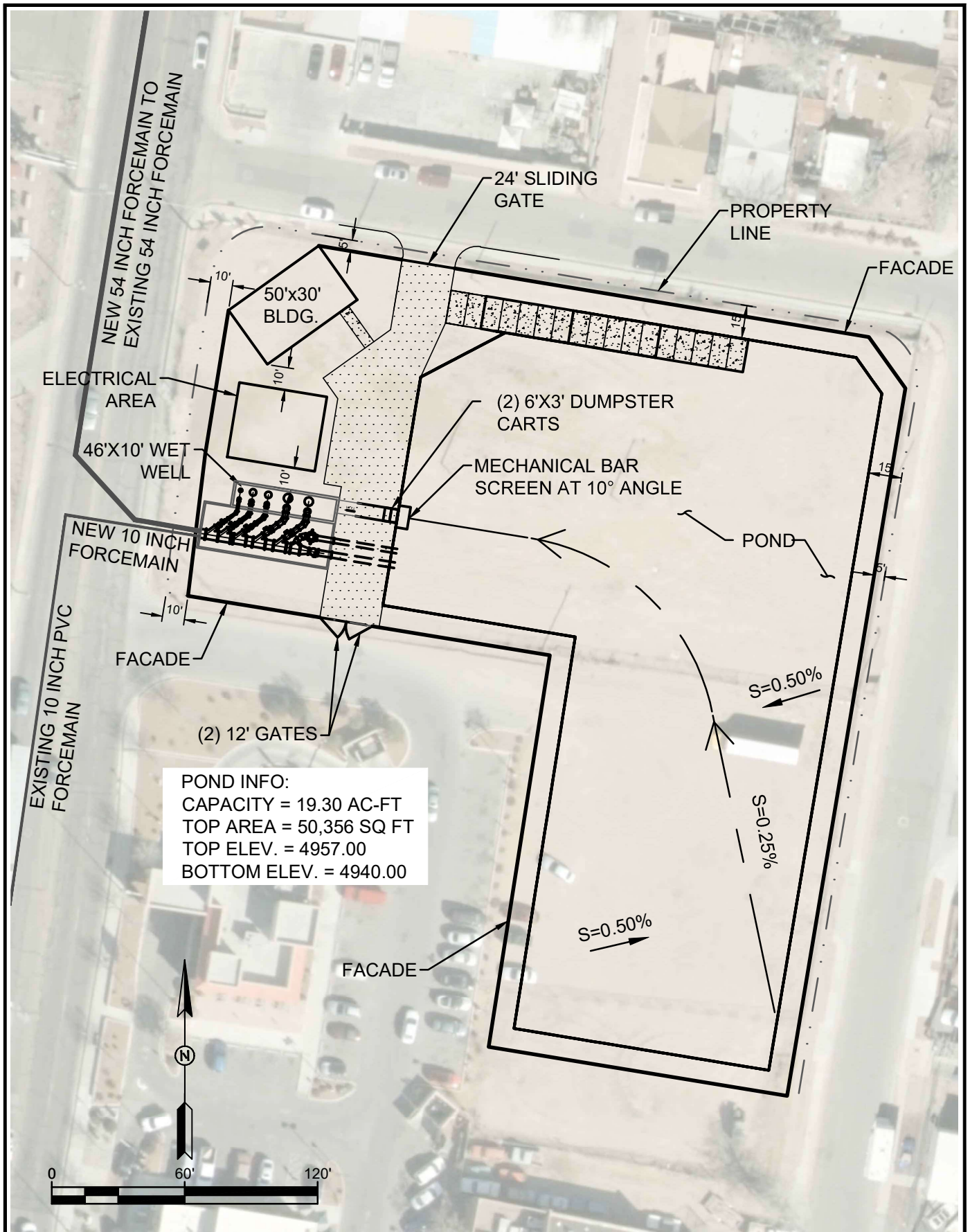
Item #	Bid Item	Description	Unit	Quantity	Unit Cost	Total
1	4.010	Construction Staking, Complete	LS	1	\$40,000.00	\$40,000.00
2	6.010	Construction Project Sign, per Contract special provisions	EA	2	\$700.00	\$1,400.00
3	6.050	Construction Mobilization, Complete.	%	7.0%	\$877,000.00	\$877,000.00
4	19.010	Temporary Traffic Control and Barricading, Complete.	LS	1	\$100,000.00	\$100,000.00
5	201.010	Site Clearing,Grubbing, and removal and disposal of obstructions, complete	LS	1	\$150,000.00	\$150,000.00
6	201.060	Temporary Erosion and Sediment Control, complete	LS	1	\$20,000.00	\$20,000.00
7	205.012	Haul of Excess Material from site, complete.	CY	30000	\$15.00	\$450,000.00
8	207.019	Sanitary, water and storm drain lines, Fill with lean fill, complete.	CY	500	\$120.00	\$60,000.00
9	204.010	Excavate Unclassified Material, complete	CY	30000	\$10.00	\$300,000.00
10	301.020	Subgrade Prep. 12" at 95% compaction, complete in place.	SY	7700	\$3.00	\$23,100.00
11	302.010	Aggregate Base Course, crushed,6" at 95% compaction, complete in place. Standard Drawing 2408	SY	7700	\$7.00	\$53,900.00
12	336.024	Furnish and place asphalt concrete, 3" thick, Superpave per Standard Specification section 336, complete and in place.	SY	3800	\$25.00	\$95,000.00
13	336.025	Furnish and place asphalt concrete, 2- 3.5" lifts, Superpave per Standard Specification section 336, complete and in place.	SY	3900	\$35.00	\$136,500.00
14	340.010	Sidewalk, 4" thick, Portland Cement Concrete, incl. subgrade compaction, complete in place. SD 2430	SY	2100	\$50.00	\$105,000.00
15	340.030	Wheelchair Access Ramp, 4" PCC, Std. Curb., complete in place. SD 2418	EA	18	\$2,500.00	\$45,000.00
16	340.050	Curb & Gutter, Standard, Portland Cement Concrete, incl. subgrade preparation, complete in place. SD 2415	LF	2800	\$20.00	\$56,000.00
17	343.030	Existing Pavement, Asphalt Concrete, more than 4" thick, sawcut, remove & dispose, complete.	SY	7200	\$9.00	\$64,800.00
18	343.080	Existing Curb & Gutter or Valley Gutter, PC Concrete ,remove & dispose, complete.	LF	2800	\$6.00	\$16,800.00
19	343.085	Existing sidewalk, 4" PC Concrete, remove and dispose	SY	2100	\$8.00	\$16,800.00
20	550.070	Furnish and install coated steel railing, Standard Specification 550, complete.	LF	1250	\$50.00	\$62,500.00
21	440.001	Reflectorized Painted Marking, 4" width, cip.	LF	2750	\$1.00	\$2,750.00
22	410.040	Existing Chain Link Fence, remove and salvage, complete	LF	1400	\$3.00	\$4,200.00
23	510.110	Structural Reinforced Concrete including formwork, complete in place.	CY	2800	\$650.00	\$1,820,000.00
24	701.110	Trenching, Backfilling, & Compaction, for 18" to 36" sewer pipe, over 8' to 12' in depth, pipe not incl., complete	LF	700	\$27.00	\$18,900.00
25	701.210	Trenching, Backfilling, & Compaction, over 60" sewer pipe, 12' to 16' in depth, pipe not incl., complete	LF	1850	\$48.00	\$88,800.00
26	801.002	6" Waterline Pipe excl. fittings,(std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$25.00	\$2,500.00
27	801.004	10" Waterline Pipe excl. fittings,(std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$35.00	\$3,500.00
28	801.015	54" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire. trench & Compacted backfill, to 6' depth, cip.	LF	700	\$300.00	\$210,000.00
29	801.059	Non-pressurized Connection.existing waterline, all sizes, incl. fittings, complete	EA	2	\$20,000.00	\$40,000.00
30	801.067	Ductile Iron MJ Fittings, Class 250, 36" to 54", including jointing material, complete in place.	LB	17000	\$4.00	\$68,000.00
31	801.081	6" Gate Valve, cip. SD 2333	EA	1	\$1,000.00	\$1,000.00
32	801.113	Fire Hydrant, 4' bury, MJ, incl. blocking & aggregate, cip. SD 2340	EA	1	\$3,500.00	\$3,500.00
33	802.500	Water Meter Box, 3/4" to 1", incl. concrete pad, cover & lid, cip., SD 2366	EA	1	\$700.00	\$700.00
34	802.600	3/4" Water Service Line, new single connection to existing watermain, cip.	EA	1	\$650.00	\$650.00
35	910.009	24" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	700	\$45.00	\$31,500.00
36	910.027	66" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	1850	\$220.00	\$407,000.00
37	910.105	Drainline Removal, greater than 48", excl. trenching, complete	LF	1500	\$60.00	\$90,000.00
38	915.020	Catch Basin, Type "A", Double Grate, complete in place. Standard Drawing 2201	EA	25	\$3,500.00	\$87,500.00

39	920.220	Manhole, 8' dia. Type "C" or "E", 10' to 14' deep, cip. SD2101	EA	10	\$11,000.00	\$110,000.00
40		Site Piping	LS	1	\$200,000.00	\$200,000.00
41		Pumps	LS	1	\$1,450,000.00	\$1,450,000.00
42		Building	SF	1500	\$150.00	\$225,000.00
43		Site gates	LS	1	\$20,000.00	\$20,000.00
44		Façade	SF	15000	\$15.00	\$225,000.00
45		Valve Vault Fittings and Header pipe, complete in place.	LS	1	\$475,000.00	\$475,000.00
46		Grading and Compaction	SY	8500	\$5.00	\$42,500.00
47		Barscreen	LS	1	\$245,000.00	\$245,000.00
48		HVAC	LS	1	\$50,000.00	\$50,000.00
49		Landscaping	LS	1	\$100,000.00	\$100,000.00
50		Electrical Equipment, complete in place.	LS	1	\$1,160,000.00	\$1,160,000.00
51		Electrical Utility or Generator Budget	LS	1	\$1,900,000.00	\$1,900,000.00
52		Utility Relocation	ALLOW	1	\$300,000.00	\$300,000.00
53		Temporary Construction Shoring	LF	1250	\$1,000.00	\$1,250,000.00
54		Start-up and Training	LS	1	\$100,000.00	\$100,000.00

Subtotal	\$13,406,800.00
Contingencies @30%	\$4,022,040.00
Gross Receipts Tax @7.875%	\$1,372,521.15
<b>Total</b>	<b>\$18,800,000</b>

BOND DATA	BIIMP QUITTELOW
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Pond Data				Pump Station							
Volume (AC-FT)	Contour Elevation	Depth (FT)	Area (FT <sup>2</sup> )	Pump#1 (CFS)	Pump#2 (CFS)	Pump#3 (CFS)	Pump#4 (CFS)	Pump#5 (CFS)	Pump#6 (CFS)	Pump #7 (CFS)	Total Outflow (CFS)
0.0	4939	0	43155	0	0	0	0	0	0	0	0
1.0	4940	1	43279	1.5	0	0	0	0	0	0	1.5
2.0	4941	2	43403	1.5	0	0	0	0	0	0	1.5
3.0	4942	3	43526	1.5	15	0	0	0	0	0	16.5
4.0	4943	4	43650	1.5	15	15	0	0	0	0	31.5
5.0	4944	5	43774	0	15	15	25	0	0	0	55
6.0	4945	6	43897	0	15	15	25	25	0	0	80
7.0	4946	7	44021	0	15	15	25	25	0	0	80
8.0	4947	8	44144	0	15	15	25	25	0	0	80
9.0	4948	9	44268	0	15	15	25	25	0	0	80
10.1	4949	10	44391	0	15	15	25	25	0	0	80
11.1	4950	11	44515	0	15	15	25	25	0	0	80
12.1	4951	12	44639	0	15	15	25	25	0	0	80
13.1	4952	13	44762	0	15	15	25	25	0	0	80
14.2	4953	14	44886	0	15	15	25	25	0	0	80
15.2	4954	15	45010	0	15	15	25	25	0	0	80
16.2	4955	16	45134	0	15	15	25	25	0	0	80
17.3	4956	17	45259	0	15	15	25	25	0	0	80
18.3	4957	18	45388	0	15	15	25	25	0	0	80
17.9 Acre Feet Storage Required				16 Hours for sump pump to empty pond							



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# MARBLE ARNO STORM DRAINAGE DESIGN CONCEPTUAL DESIGN STUDY

OPTION 2B: 80 CFS DISCHARGE WITH SECANT PILE  
WALLS

JOB NO:  
118102

DATE:  
JULY 2018

SHEET NO:  
A-4

## Engineers Opinion of Probable Construction Costs

## Marble-Arno Storm Drainage Design Option #2B: 80 cfs Discharge and Detention Pond with Secant Pile Walls

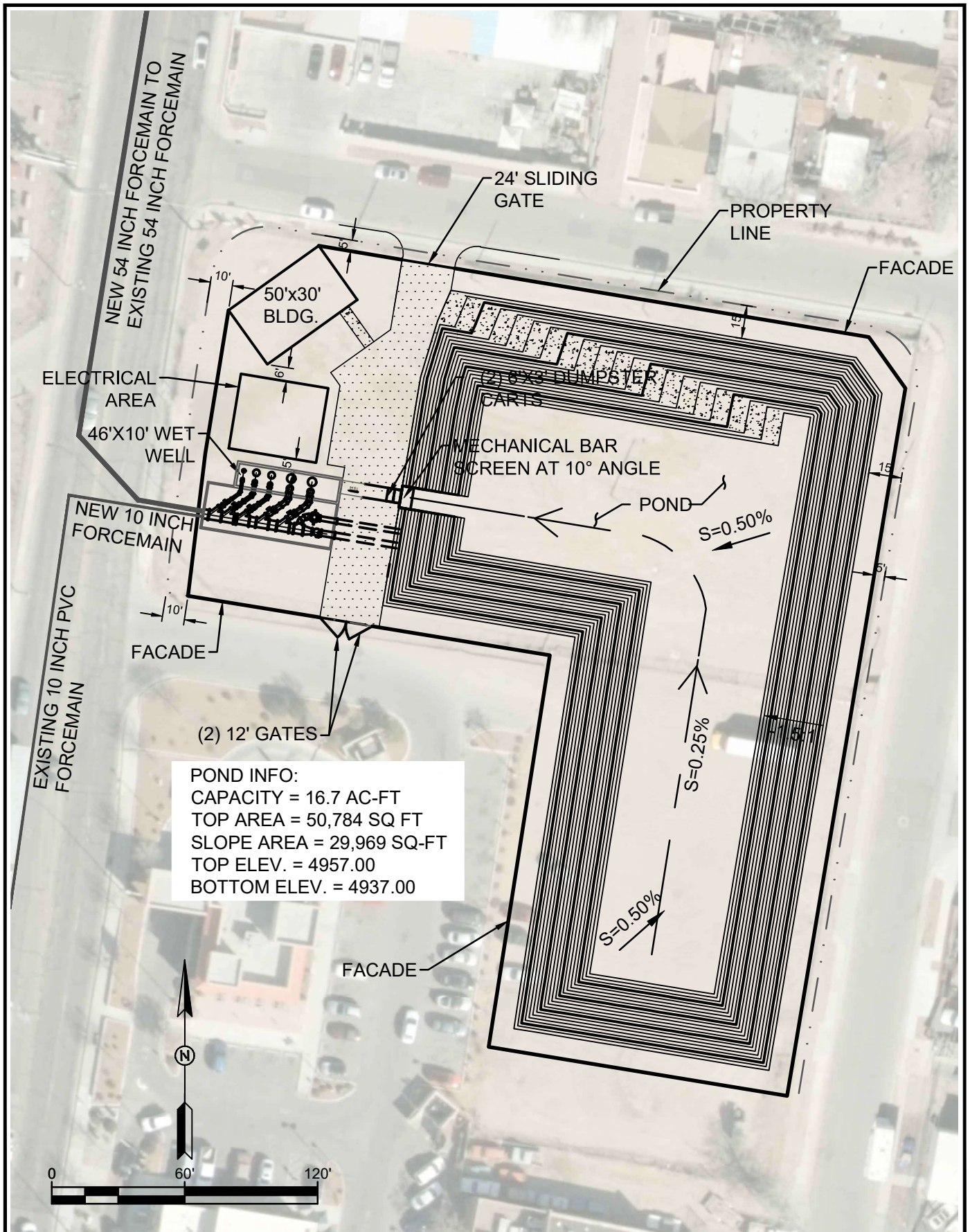
Item #	Bid Item	Description	Unit	Quantity	Unit Cost	Total
1	4.010	Construction Staking, Complete	LS	1	\$40,000.00	\$40,000.00
2	6.010	Construction Project Sign, per Contract special provisions	EA	2	\$700.00	\$1,400.00
3	6.050	Construction Mobilization, Complete.	%	7.0%	\$950,000.00	\$950,000.00
4	19.010	Temporary Traffic Control and Barricading, Complete.	LS	1	\$100,000.00	\$100,000.00
5	201.010	Site Clearing, Grubbing, and removal and disposal of obstructions, complete	LS	1	\$150,000.00	\$150,000.00
6	201.060	Temporary Erosion and Sediment Control, complete.	LS	1	\$20,000.00	\$20,000.00
7	205.012	Haul of Excess Material from site, complete.	CY	31500	\$15.00	\$472,500.00
8	207.019	Sanitary, water and storm drain lines, Fill with lean fill, complete.	CY	500	\$120.00	\$60,000.00
9	204.010	Excavate Unclassified Material, Complete	CY	31500	\$10.00	\$315,000.00
10	301.020	Subgrade Prep. 12" at 95% compaction, complete in place.	SY	7700	\$3.00	\$23,100.00
11	302.010	Aggregate Base Course, crushed, 6" at 95% compaction, complete in place. Standard Drawing 2408	SY	7700	\$7.00	\$53,900.00
12	336.024	Furnish and place asphalt concrete, 3" thick, Superpave per Standard Specification section 336, complete and in place.	SY	3800	\$25.00	\$95,000.00
13	336.025	Furnish and place asphalt concrete, 2- 3.5" lifts, Superpave per Standard Specification section 336, complete and in place.	SY	3900	\$35.00	\$136,500.00
14	340.010	Sidewalk, 4" thick, Portland Cement Concrete, incl. subgrade compaction, complete in place. SD 2430	SY	2100	\$50.00	\$105,000.00
15	340.030	Wheelchair Access Ramp, 4" PCC, Std. Curb., complete in place. SD 2418	EA	18	\$2,500.00	\$45,000.00
16	340.050	Curb & Gutter, Standard, Portland Cement Concrete, incl. subgrade preparation, complete in place. SD 2415	LF	2800	\$20.00	\$56,000.00
17	343.030	Existing Pavement, Asphalt Concrete, more than 4" thick, sawcut, remove & dispose, complete.	SY	7200	\$9.00	\$64,800.00
18	343.080	Existing Curb & Gutter or Valley Gutter, PC Concrete, remove & dispose, complete.	LF	2800	\$6.00	\$16,800.00
19	343.085	Existing sidewalk, 4" PC Concrete, remove and dispose	SY	2100	\$8.00	\$16,800.00
20	550.070	Furnish and install coated steel railing, Standard Specification 550, complete.	LF	1300	\$50.00	\$65,000.00
21	440.001	Reflectorized Painted Marking, 4" width, cip.	LF	2750	\$1.00	\$2,750.00
22	410.040	Existing Chain Link Fence, remove and salvage, complete	LF	1400	\$3.00	\$4,200.00
23	510.110	Structural Reinforced Concrete including formwork, complete in place.	CY	710	\$650.00	\$461,500.00
25	520.036	Drilled concrete secant pile, including concrete and reinforcing steel, 36" diameter, complete in place.	VF	11500	\$300.00	\$3,450,000.00
26	701.110	Trenching, Backfilling, & Compaction, for 18" to 36" sewer pipe, over 8' to 12' in depth, pipe not incl., complete	LF	700	\$27.00	\$18,900.00
28	701.210	Trenching, Backfilling, & Compaction, over 60" sewer pipe, 12' to 16' in depth, pipe not incl., complete	LF	1850	\$48.00	\$88,800.00
29	801.002	6" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$25.00	\$2,500.00
30	801.004	10" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$35.00	\$3,500.00
31	801.015	54" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill, to 6' depth, cip.	LF	700	\$300.00	\$210,000.00
32	801.059	Non-pressurized Connection existing waterline, all sizes, incl. fittings, complete	EA	2	\$20,000.00	\$40,000.00
33	801.067	Ductile Iron MJ Fittings, Class 250, 36" to 54", including jointing material, complete in place.	LB	17000	\$4.00	\$68,000.00
34	801.081	6" Gate Valve, cip. SD 2333	EA	1	\$1,000.00	\$1,000.00
35	801.113	Fire Hydrant, 4' bury, MJ, incl. blocking & aggregate, cip. SD 2340	EA	1	\$3,500.00	\$3,500.00
36	802.500	Water Meter Box, 3/4" to 1", incl. concrete pad, cover & lid, cip., SD 2366	EA	1	\$700.00	\$700.00
37	802.600	3/4" Water Service Line, new single connection to existing watermain, cip.	EA	1	\$650.00	\$650.00
39	910.009	24" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	700	\$45.00	\$31,500.00
41	910.027	66" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	1850	\$220.00	\$407,000.00
45	910.105	Drainline Removal, greater than 48", excl. trenching, complete	LF	1500	\$60.00	\$90,000.00

46	915.020	Catch Basin, Type "A", Double Grate, complete in place. Standard Drawing 2201	EA	25	\$3,500.00	\$87,500.00
49	920.220	Manhole, 8' dia. Type "C" or "E", 10' to 14' deep, cip. SD2101	EA	10	\$11,000.00	\$110,000.00
51		Site Piping	LS	1	\$200,000.00	\$200,000.00
52		Pumps	LS	1	\$1,450,000.00	\$1,450,000.00
53		Building	SF	1500	\$150.00	\$225,000.00
54		Site gates	LS	1	\$20,000.00	\$20,000.00
55		Façade	SF	15000	\$15.00	\$225,000.00
56		Valve Vault Fittings and Header pipe, complete in place.	LS	1	\$475,000.00	\$475,000.00
57		Grading and Compaction	SY	8500	\$5.00	\$42,500.00
58		Barscreen	LS	1	\$245,000.00	\$245,000.00
59		HVAC	LS	1	\$50,000.00	\$50,000.00
60		Landscaping	LS	1	\$100,000.00	\$100,000.00
50		Electrical Equipment, complete in place.	LS	1	\$1,160,000.00	\$1,160,000.00
51		Electrical Utility or Generator Budget	LS	1	\$1,900,000.00	\$1,900,000.00
52		Utility Relocation	ALLOW	1	\$300,000.00	\$300,000.00
53		Temporary Construction Shoring	LF	160	\$1,000.00	\$160,000.00
54		Start-up and Training	LS	1	\$100,000.00	\$100,000.00

Subtotal	\$14,521,300.00
Contingencies @30%	\$4,356,390.00
Gross Receipts Tax @7.875%	\$1,486,618.09
<b>Total</b>	<b>\$20,400,000</b>







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# MARBLE ARNO STORM DRAINAGE DESIGN CONCEPTUAL DESIGN STUDY

OPTION 2C: 80 CFS DISCHARGE WITH CONCRETE LINED  
1.5:1 SIDE SLOPES

JOB NO:  
118102

DATE:  
JULY 2018

SHEET NO:  
A-5

## Engineers Opinion of Probable Construction Costs

## Marble-Arno Storm Drainage Design Option #2C: 80 cfs Discharge and Detention Pond with Shotcrete Lined 1.5:1 Slopes

Item #	Bid Item	Description	Unit	Quantity	Unit Cost	Total
1	4.010	Construction Staking, Complete	LS	1	\$40,000.00	\$40,000.00
2	6.010	Construction Project Sign, per Contract special provisions	EA	2	\$700.00	\$1,400.00
3	6.050	Construction Mobilization, Complete.	%	7.0%	\$731,000.00	\$731,000.00
4	19.010	Temporary Traffic Control and Barricading, Complete.	LS	1	\$100,000.00	\$100,000.00
5	201.010	Site Clearing, Grubbing, and removal and disposal of obstructions, complete	LS	1	\$150,000.00	\$150,000.00
6	201.060	Temporary Erosion and Sediment Control, Complete	LS	1	\$20,000.00	\$20,000.00
7	205.012	Haul of Excess Material from site, complete.	CY	27000	\$15.00	\$405,000.00
8	207.019	Sanitary, water and storm drain lines, Fill with lean fill, complete.	CY	500	\$120.00	\$60,000.00
9	204.010	Excavate Unclassified Material, complete	CY	27000	\$10.00	\$270,000.00
10	301.020	Subgrade Prep. 12" at 95% compaction, complete in place.	SY	7700	\$3.00	\$23,100.00
11	302.010	Aggregate Base Course, crushed, 6" at 95% compaction, complete in place. Standard Drawing 2408	SY	7700	\$7.00	\$53,900.00
12	336.024	Furnish and place asphalt concrete, 3" thick, Superpave per Standard Specification section 336, complete and in place.	SY	3800	\$25.00	\$95,000.00
13	336.025	Furnish and place asphalt concrete, 2- 3.5" lifts, Superpave per Standard Specification section 336, complete and in place.	SY	3900	\$35.00	\$136,500.00
14	340.010	Sidewalk, 4" thick, Portland Cement Concrete, incl. subgrade compaction, complete in place. SD 2430	SY	2100	\$50.00	\$105,000.00
15	340.030	Wheelchair Access Ramp, 4" PCC, Std. Curb., complete in place. SD 2418	EA	18	\$2,500.00	\$45,000.00
16	340.050	Curb & Gutter, Standard, Portland Cement Concrete, incl. subgrade preparation, complete in place. SD 2415	LF	2800	\$20.00	\$56,000.00
17	343.030	Existing Pavement, Asphalt Concrete, more than 4" thick, sawcut, remove & dispose, complete.	SY	7200	\$9.00	\$64,800.00
18	343.080	Existing Curb & Gutter or Valley Gutter, PC Concrete, remove & dispose, complete.	LF	2800	\$6.00	\$16,800.00
19	343.085	Existing sidewalk, 4" PC Concrete, remove and dispose	SY	2100	\$8.00	\$16,800.00
20	550.070	Furnish and install coated steel railing, Standard Specification 550, complete.	LF	160	\$50.00	\$8,000.00
21	440.001	Reflectorized Painted Marking, 4" width, cip.	LF	2750	\$1.00	\$2,750.00
22	410.040	Existing Chain Link Fence, remove and salvage, complete	LF	1400	\$3.00	\$4,200.00
23	510.110	Structural Reinforced Concrete including formwork, complete in place.	CY	720	\$650.00	\$468,000.00
24	605.011	Pond Slopes Lining, 6" PCC Shotcrete 4000 psi incl. reinforcement and subgrade preparation	SY	3350	\$135.00	\$452,250.00
25	701.110	Trenching, Backfilling, & Compaction, for 18" to 36" sewer pipe, over 8' to 12' in depth, pipe not incl., complete	LF	700	\$27.00	\$18,900.00
26	701.210	Trenching, Backfilling, & Compaction, over 60" sewer pipe, 12' to 16' in depth, pipe not incl., complete	LF	1850	\$48.00	\$88,800.00
27	801.002	6" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$25.00	\$2,500.00
28	801.004	10" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$35.00	\$3,500.00
29	801.015	54" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire, trench & Compacted backfill, to 6' depth, cip.	LF	700	\$300.00	\$210,000.00
30	801.059	Non-pressurized Connection existing waterline, all sizes, incl. fittings, complete	EA	2	\$20,000.00	\$40,000.00
31	801.067	Ductile Iron MJ Fittings, Class 250, 36" to 54", including jointing material, complete in place.	LB	17000	\$4.00	\$68,000.00
32	801.081	6" Gate Valve, cip. SD 2333	EA	1	\$1,000.00	\$1,000.00
33	801.113	Fire Hydrant, 4' bury, MJ, incl. blocking & aggregate, cip. SD 2340	EA	1	\$3,500.00	\$3,500.00
34	802.500	Water Meter Box, 3/4" to 1", incl. concrete pad, cover & lid, cip., SD 2366	EA	1	\$700.00	\$700.00
35	802.600	3/4" Water Service Line, new single connection to existing watermain, cip.	EA	1	\$650.00	\$650.00
36	910.009	24" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	700	\$45.00	\$31,500.00
37	910.027	66" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	1850	\$220.00	\$407,000.00
38	910.105	Drainline Removal, greater than 48", excl. trenching, complete	LF	1500	\$60.00	\$90,000.00

39	915.020	Catch Basin, Type "A", Double Grate, complete in place. Standard Drawing 2201	EA	25	\$3,500.00	\$87,500.00
40	920.220	Manhole, 8' dia. Type "C" or "E", 10' to 14' deep, cip. SD2101	EA	10	\$11,000.00	\$110,000.00
41		Site Piping	LS	1	\$200,000.00	\$200,000.00
42		Pumps	LS	1	\$1,450,000.00	\$1,450,000.00
43		Building	SF	1500	\$150.00	\$225,000.00
44		Site gates	LS	1	\$20,000.00	\$20,000.00
45		Façade	SF	15000	\$15.00	\$225,000.00
46		Valve Vault Fittings and Header pipe, complete in place.	LS	1	\$475,000.00	\$475,000.00
47		Grading and Compaction	SY	8500	\$5.00	\$42,500.00
48		Barscreen	LS	1	\$250,000.00	\$250,000.00
49		HVAC	LS	1	\$50,000.00	\$50,000.00
50		Landscaping	LS	1	\$100,000.00	\$100,000.00
51		Electrical Equipment, complete in place.	LS	1	\$1,160,000.00	\$1,160,000.00
52		Electrical Utility or Generator Budget	LS	1	\$1,900,000.00	\$1,900,000.00
53		Utility Relocation	ALLOW	1	\$300,000.00	\$300,000.00
54		Temporary Construction Shoring	LF	160	\$1,200.00	\$192,000.00
55		Start-up and Training	LS	1	\$100,000.00	\$100,000.00

Subtotal	\$11,178,550.00
Contingencies @30%	\$3,353,565.00
Gross Receipts Tax @7.875%	\$1,144,404.06
<b>Total</b>	<b>\$15,700,000</b>

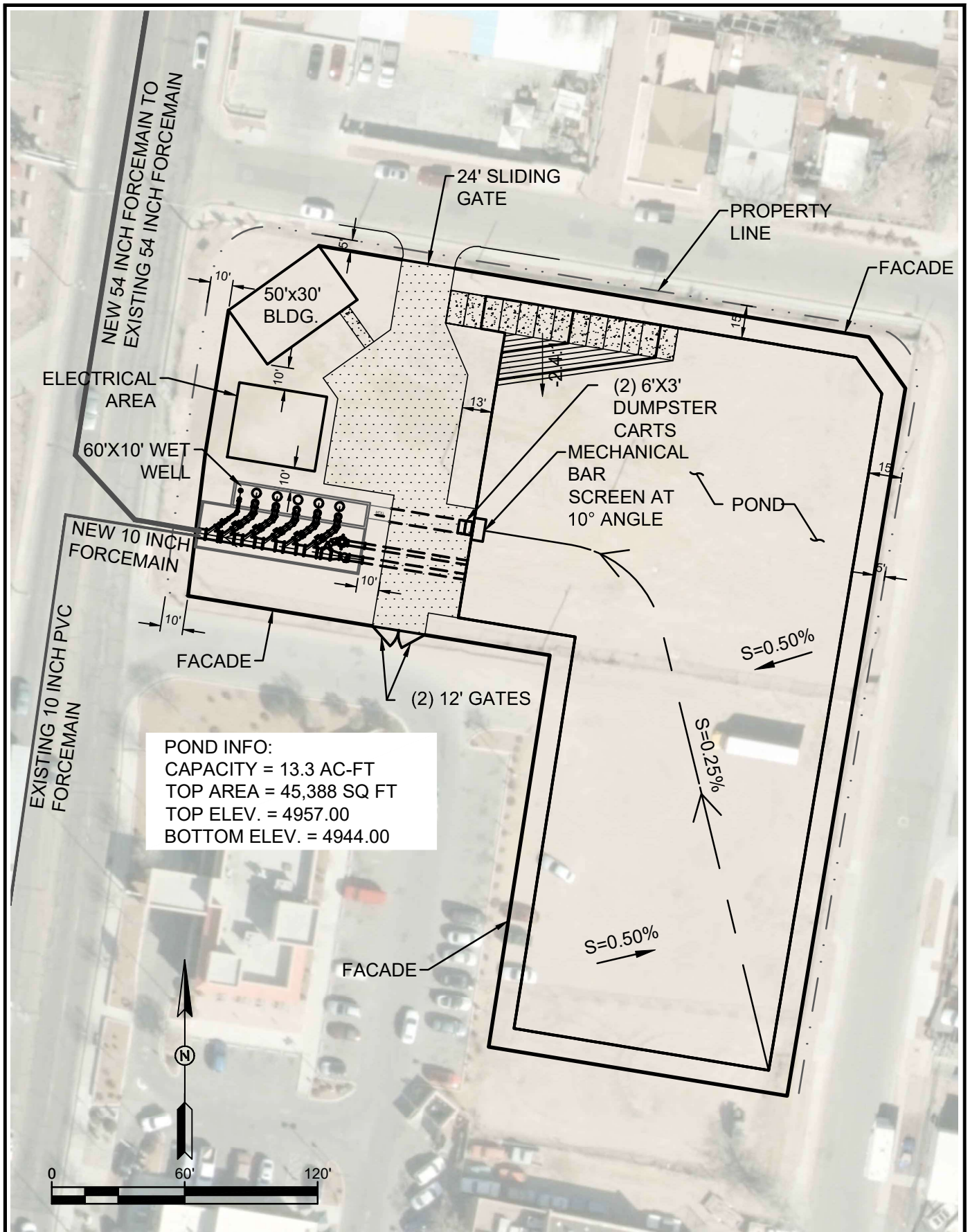
POND DATA				PUMP OUTFLOW							
Volume (AC-FT)	Contour Elevation	Depth (FT)	Area (FT <sup>2</sup> )	Pump#1 (CFS)	Pump#2 (CFS)	Pump#3 (CFS)	Pump#4 (CFS)	Pump#5 (CFS)	Pump#6 (CFS)	Pump #7 (CFS)	Total Outflow (CFS)
0.0	4937	0	21739	0	0	0	0	0	0	0	0
0.5	4938	1	23014	1.5	0	0	0	0	0	0	1.5
1.1	4939	2	24309	1.5	0	0	0	0	0	0	1.5
1.7	4940	3	25621	1.5	15	0	0	0	0	0	16.5
2.3	4941	4	26952	1.5	15	15	0	0	0	0	31.5
2.9	4942	5	28302	0	15	15	25	0	0	0	55
3.6	4943	6	29670	0	15	15	25	25	0	0	80
4.3	4944	7	31057	0	15	15	25	25	0	0	80
5.1	4945	8	32463	0	15	15	25	25	0	0	80
5.9	4946	9	33888	0	15	15	25	25	0	0	80
6.7	4947	10	35331	0	15	15	25	25	0	0	80
7.5	4948	11	36793	0	15	15	25	25	0	0	80
8.4	4949	12	38273	0	15	15	25	25	0	0	80
9.3	4950	13	39772	0	15	15	25	25	0	0	80
10.3	4951	14	41290	0	15	15	25	25	0	0	80
11.2	4952	15	42826	0	15	15	25	25	0	0	80
12.3	4953	16	44380	0	15	15	25	25	0	0	80
13.3	4954	17	45853	0	15	15	25	25	0	0	80
14.4	4955	18	47545	0	15	15	25	25	0	0	80
15.5	4956	19	49155	0	15	15	25	25	0	0	80
16.7	4957	20	50785	0	15	15	25	25	0	0	80
15.9 Acre Feet Storage Required				9 Hours for sump pump to empty pond							

## APPENDIX C: OPTION 3- 130 CFS PUMP STATION ALTERNATIVES

Appendix C contains the conceptual layouts, opinion of costs, and pond routing summary considered for the 130 cfs pump station option.







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Building 4, Suite 200  
Albuquerque, NM 87110  
Phone: 505-884-0700  
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# MARBLE ARNO STORM DRAINAGE DESIGN CONCEPTUAL DESIGN STUDY

OPTION 3A: 130 CFS DISCHARGE WITH CANTILEVER  
WALLS

JOB NO:  
118102

DATE:  
JULY 2018

SHEET NO:  
A-6

## Engineers Opinion of Probable Construction Costs

## Marble-Arno Storm Drainage Design Option #3A: 130 cfs Discharge and Detention Pond with Cantilever Walls

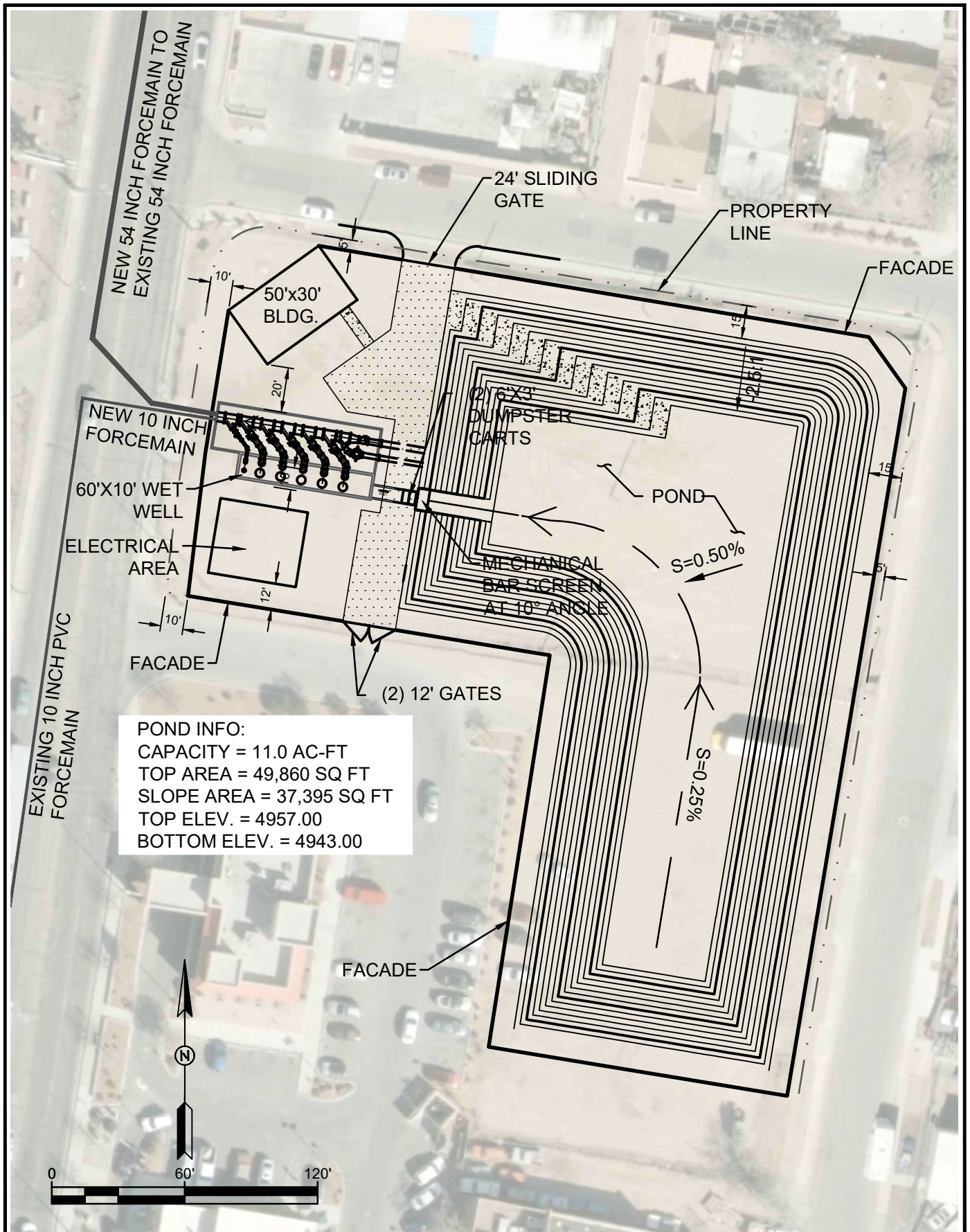
Item #	Bid Item	Description	Unit	Quantity	Unit Cost	Total
1	4.010	Construction Staking, Complete	LS	1	\$40,000.00	\$40,000.00
2	6.010	Construction Project Sign, per Contract special provisions	EA	2	\$700.00	\$1,400.00
3	6.050	Construction Mobilization, Complete.	%	7.0%	\$974,000.00	\$974,000.00
4	19.010	Temporary Traffic Control and Barricading, Complete.	LS	1	\$100,000.00	\$100,000.00
5	201.010	Site Clearing,Grubbing, and removal and disposal of obstructions, complete	LS	1	\$150,000.00	\$150,000.00
6	201.060	Temporary Erosion and Sediment Control, Complete.	LS	1	\$20,000.00	\$20,000.00
7	205.012	Haul of Excess Material from site, complete.	CY	21500	\$15.00	\$322,500.00
8	207.019	Sanitary, water and storm drain lines, Fill with lean fill, complete.	CY	500	\$120.00	\$60,000.00
9	204.010	Excavate Unclassified Material, complete	CY	21500	\$10.00	\$215,000.00
10	301.020	Subgrade Prep. 12" at 95% compaction, complete in place.	SY	7700	\$3.00	\$23,100.00
11	302.010	Aggregate Base Course, crushed,6" at 95% compaction, complete in place. Standard Drawing 2408	SY	7700	\$7.00	\$53,900.00
12	336.024	Furnish and place asphalt concrete, 3" thick, Superpave per Standard Specification section 336, complete and in place.	SY	3800	\$25.00	\$95,000.00
13	336.025	Furnish and place asphalt concrete, 2- 3.5" lifts, Superpave per Standard Specification section 336, complete and in place.	SY	3900	\$35.00	\$136,500.00
14	340.010	Sidewalk, 4" thick, Portland Cement Concrete, incl. subgrade compaction, complete in place. SD 2430	SY	2100	\$50.00	\$105,000.00
15	340.030	Wheelchair Access Ramp, 4" PCC, Std. Curb., complete in place. SD 2418	EA	18	\$2,500.00	\$45,000.00
16	340.050	Curb & Gutter, Standard, Portland Cement Concrete, incl. subgrade preparation, complete in place. SD 2415	LF	2800	\$20.00	\$56,000.00
17	343.030	Existing Pavement, Asphalt Concrete, more than 4" thick, sawcut, remove & dispose, complete.	SY	7200	\$9.00	\$64,800.00
18	343.080	Existing Curb & Gutter or Valley Gutter, PC Concrete ,remove & dispose, complete.	LF	2800	\$6.00	\$16,800.00
19	343.085	Existing sidewalk, 4" PC Concrete, remove and dispose	SY	2100	\$8.00	\$16,800.00
20	550.070	Furnish and install coated steel railing, Standard Specification 550, complete.	LF	1250	\$50.00	\$62,500.00
21	440.001	Reflectorized Painted Marking, 4" width, cip.	LF	2750	\$1.00	\$2,750.00
22	410.040	Existing Chain Link Fence, remove and salvage, complete	LF	1400	\$3.00	\$4,200.00
23	510.110	Structural Reinforced Concrete including formwork, complete in place.	CY	1880	\$650.00	\$1,222,000.00
24	701.11	Trenching, Backfilling, & Compaction, for 18" to 36" sewer pipe, over 8' to 12' in depth, pipe not incl., complete	LF	700	\$27.00	\$18,900.00
25	701.21	Trenching, Backfilling, & Compaction, over 60" sewer pipe, 12' to 16' in depth, pipe not incl., complete	LF	1850	\$48.00	\$88,800.00
26	801.002	6" Waterline Pipe excl. fittings,(std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$25.00	\$2,500.00
27	801.004	10" Waterline Pipe excl. fittings,(std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$35.00	\$3,500.00
28	801.015	54" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire. trench & Compacted backfill, to 6' depth, cip.	LF	700	\$300.00	\$210,000.00
29	801.059	Non-pressurized Connection.existing waterline, all sizes, incl. fittings, complete	EA	2	\$20,000.00	\$40,000.00
30	801.067	Ductile Iron MJ Fittings, Class 250, 36" to 54", including jointing material, complete in place.	LB	17000	\$4.00	\$68,000.00
31	801.081	6" Gate Valve, cip. SD 2333	EA	1	\$1,000.00	\$1,000.00
32	801.113	Fire Hydrant, 4' bury, MJ, incl. blocking & aggregate, cip. SD 2340	EA	1	\$3,500.00	\$3,500.00
33	802.500	Water Meter Box, 3/4" to 1", incl. concrete pad, cover & lid, cip., SD 2366	EA	1	\$700.00	\$700.00
34	802.600	3/4" Water Service Line, new single connection to existing watermain, cip.	EA	1	\$650.00	\$650.00
35	910.009	24" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	700	\$45.00	\$31,500.00
36	910.027	66" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	1850	\$220.00	\$407,000.00
37	910.105	Drainline Removal, greater than 48", excl. trenching, complete	LF	1500	\$60.00	\$90,000.00
38	915.020	Catch Basin, Type "A", Double Grate, complete in place. Standard Drawing 2201	EA	25	\$3,500.00	\$87,500.00



39	920.220	Manhole, 8' dia. Type "C" or "E", 10' to 14' deep, cip. SD2101	EA	10	\$11,000.00	\$110,000.00
40		Site Piping	LS	1	\$200,000.00	\$200,000.00
41		Pumps	LS	1	\$2,500,000.00	\$2,500,000.00
42		Building	SF	1500	\$150.00	\$225,000.00
43		Site gates	LS	1	\$20,000.00	\$20,000.00
44		Façade	SF	15000	\$15.00	\$225,000.00
45		Valve Vault Fittings and Header pipe, complete in place.	LS	1	\$625,000.00	\$625,000.00
46		Grading and Compaction	SY	8500	\$5.00	\$42,500.00
47		Barscreen	LS	1	\$240,000.00	\$240,000.00
48		HVAC	LS	1	\$50,000.00	\$50,000.00
49		Landscaping	LS	1	\$100,000.00	\$100,000.00
50		Electrical Equipment, complete in place.	LS	1	\$1,250,000.00	\$1,250,000.00
51		Electrical Utility or Generator Budget	LS	1	\$3,050,000.00	\$3,050,000.00
52		Utility Relocation	ALLOW	1	\$300,000.00	\$300,000.00
53		Temporary Construction Shoring	LF	1260	\$800.00	\$1,008,000.00
54		Start-up and Training	LS	1	\$100,000.00	\$100,000.00

Subtotal	\$14,886,300.00
Contingencies @30%	\$4,465,890.00
Gross Receipts Tax @7.875%	\$1,523,984.96
<b>Total</b>	<b>\$20,900,000</b>





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# MARBLE ARNO STORM DRAINAGE DESIGN CONCEPTUAL DESIGN STUDY

OPTION 3B: 130 CFS DISCHARGE WITH 2.5:1 SIDE SLOPES

JOB NO:  
118102

DATE:  
JULY 2018

SHEET NO:  
A-7

## Engineers Opinion of Probable Construction Costs

## Marble-Arno Storm Drainage Design Option #3B: 130 cfs Discharge and Detention Pond with 2.5:1 Sloped Walls

Item #	Bid Item	Description	Unit	Quantity	Unit Cost	Total
1	4.010	Construction Staking, Complete	LS	1	\$40,000.00	\$40,000.00
2	6.010	Construction Project Sign, per Contract special provisions	EA	2	\$700.00	\$1,400.00
3	6.050	Construction Mobilization, Complete.	%	7.0%	\$852,000.00	\$852,000.00
4	19.010	Temporary Traffic Control and Barricading, Complete.	LS	1	\$100,000.00	\$100,000.00
5	201.010	Site Clearing,Grubbing, and removal and disposal of obstructions, complete	LS	1	\$150,000.00	\$150,000.00
6	201.060	Temporary Erosion and Sediment Control, complete.	LS	1	\$20,000.00	\$20,000.00
7	205.012	Haul of Excess Material from site, complete.	CY	18000	\$15.00	\$270,000.00
8	207.019	Sanitary, water and storm drain lines, Fill with lean fill, complete.	CY	500	\$120.00	\$60,000.00
9	204.010	Excavate Unclassified Material, complete	CY	18000	\$10.00	\$180,000.00
10	301.020	Subgrade Prep. 12" at 95% compaction, complete in place.	SY	7700	\$3.00	\$23,100.00
11	302.010	Aggregate Base Course, crushed,6" at 95% compaction, complete in place. Standard Drawing 2408	SY	7700	\$7.00	\$53,900.00
12	336.024	Furnish and place asphalt concrete, 3" thick, Superpave per Standard Specification section 336, complete and in place.	SY	3800	\$25.00	\$95,000.00
13	336.025	Furnish and place asphalt concrete, 2- 3.5" lifts, Superpave per Standard Specification section 336, complete and in place.	SY	3900	\$35.00	\$136,500.00
14	340.010	Sidewalk, 4" thick, Portland Cement Concrete, incl. subgrade compaction, complete in place. SD 2430	SY	2100	\$50.00	\$105,000.00
15	340.030	Wheelchair Access Ramp, 4" PCC, Std. Curb., complete in place. SD 2418	EA	18	\$2,500.00	\$45,000.00
16	340.050	Curb & Gutter, Standard, Portland Cement Concrete, incl. subgrade preparation, complete in place. SD 2415	LF	2800	\$20.00	\$56,000.00
17	343.030	Existing Pavement, Asphalt Concrete, more than 4" thick, sawcut, remove & dispose, complete.	SY	7200	\$9.00	\$64,800.00
18	343.080	Existing Curb & Gutter or Valley Gutter, PC Concrete ,remove & dispose, complete.	LF	2800	\$6.00	\$16,800.00
19	343.085	Existing sidewalk, 4" PC Concrete, remove and dispose	SY	2100	\$8.00	\$16,800.00
20	550.070	Furnish and install coated steel railing, Standard Specification 550, complete.	LF	160	\$50.00	\$8,000.00
21	440.001	Reflectorized Painted Marking, 4" width, cip.	LF	2750	\$1.00	\$2,750.00
22	410.040	Existing Chain Link Fence, remove and salvage, complete	LF	1400	\$3.00	\$4,200.00
23	510.110	Structural Reinforced Concrete including formwork, complete in place.	CY	610	\$650.00	\$396,500.00
25	701.11	Trenching, Backfilling, & Compaction, for 18" to 36" sewer pipe, over 8' to 12' in depth, pipe not incl., complete	LF	700	\$27.00	\$18,900.00
27	701.21	Trenching, Backfilling, & Compaction, over 60" sewer pipe, 12' to 16' in depth, pipe not incl., complete	LF	1850	\$48.00	\$88,800.00
28	801.002	6" Waterline Pipe excl. fittings,(std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$25.00	\$2,500.00
29	801.004	10" Waterline Pipe excl. fittings,(std. spec. sec. 801), incl. trace wire, trench & Compacted backfill to 6' depth, cip.	LF	100	\$35.00	\$3,500.00
30	801.015	54" Waterline Pipe excl. fittings, (std. spec. sec. 801), incl. trace wire. trench & Compacted backfill, to 6' depth, cip.	LF	700	\$300.00	\$210,000.00
31	801.059	Non-pressurized Connection.existing waterline, all sizes, incl. fittings, complete	EA	2	\$20,000.00	\$40,000.00
32	801.067	Ductile Iron MJ Fittings, Class 250, 36" to 54", including jointing material, complete in place.	LB	17000	\$4.00	\$68,000.00
33	801.081	6" Gate Valve, cip. SD 2333	EA	1	\$1,000.00	\$1,000.00
34	801.113	Fire Hydrant, 4' bury, MJ, incl. blocking & aggregate, cip. SD 2340	EA	1	\$3,500.00	\$3,500.00
35	802.500	Water Meter Box, 3/4" to 1", incl. concrete pad, cover & lid, cip., SD 2366	EA	1	\$700.00	\$700.00
36	802.600	3/4" Water Service Line, new single connection to existing watermain, cip.	EA	1	\$650.00	\$650.00
38	910.009	24" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	700	\$45.00	\$31,500.00
40	910.027	66" Reinforced Concrete Pipe, Class III, furnish & place in open trench, cip.	LF	1850	\$220.00	\$407,000.00
44	910.105	Drainline Removal, greater than 48", excl. trenching, complete	LF	1500	\$60.00	\$90,000.00
45	915.020	Catch Basin, Type "A", Double Grate, complete in place. Standard Drawing 2201	EA	25	\$3,500.00	\$87,500.00

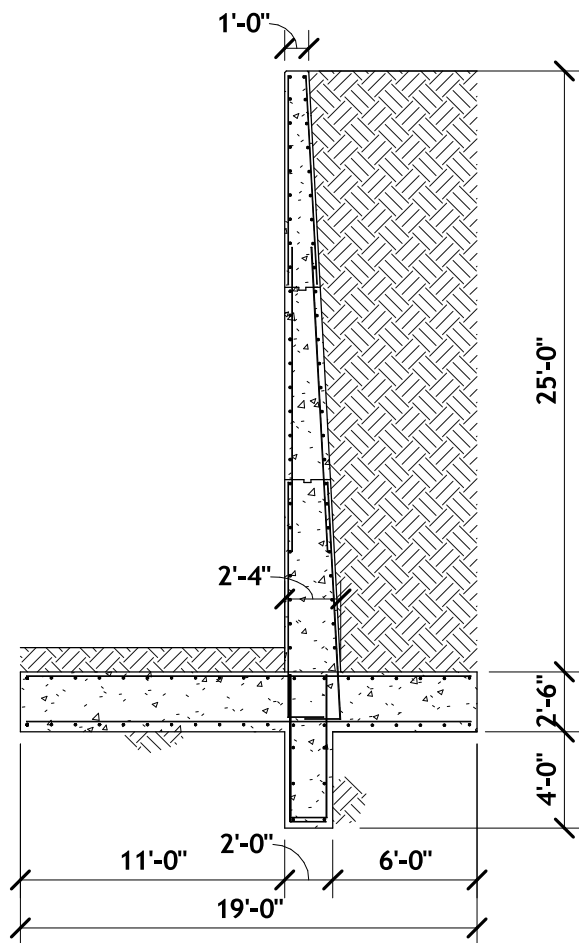
48	920.220	Manhole, 8' dia. Type "C" or "E", 10' to 14' deep, cip. SD2101	EA	10	\$11,000.00	\$110,000.00
49	1005.320	<u>Seeded</u> Gravel Mulch 2"-4" including filter fabric, complete in place.	SY	4,160	\$25.00	\$104,000.00
50		Site Piping	LS	1	\$200,000.00	\$200,000.00
51		Pumps	LS	1	\$2,500,000.00	\$2,500,000.00
52		Building	SF	1500	\$150.00	\$225,000.00
53		Site gates	LS	1	\$20,000.00	\$20,000.00
54		Façade	SF	15000	\$15.00	\$225,000.00
55		Valve Vault Fittings and Header pipe, complete in place.	LS	1	\$625,000.00	\$625,000.00
56		Grading and Compaction	SY	8500	\$5.00	\$42,500.00
57		Barscreen	LS	1	\$240,000.00	\$240,000.00
58		HVAC	LS	1	\$50,000.00	\$50,000.00
59		Landscaping	LS	1	\$100,000.00	\$100,000.00
50		Electrical Equipment, complete in place.	LS	1	\$1,250,000.00	\$1,250,000.00
51		Electrical Utility or Generator Budget	LS	1	\$3,050,000.00	\$3,050,000.00
52		Utility Relocation	ALLOW	1	\$300,000.00	\$300,000.00
53		Temporary Construction Shoring	LF	160	\$800.00	\$128,000.00
54		Start-up and Training	LS	1	\$100,000.00	\$100,000.00

Subtotal	\$13,020,800.00
Contingencies @30%	\$3,906,240.00
Gross Receipts Tax @7.875%	\$1,333,004.40
<b>Total</b>	<b>\$18,300,000</b>

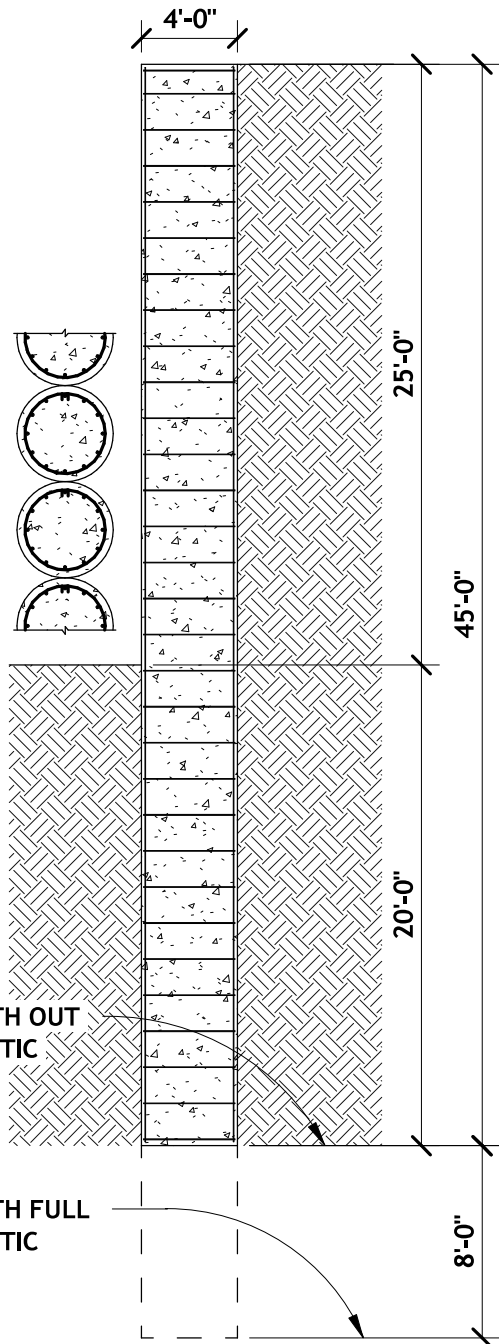
POND DATA				PUMP OUTFLOW							
Volume (AC-FT)	Contour Elevation	Depth (FT)	Area (FT²)	Pump#1 (CFS)	Pump#2 (CFS)	Pump#3 (CFS)	Pump#4 (CFS)	Pump#5 (CFS)	Pump#6 (CFS)	Pump #7 (CFS)	Total Outflow (CFS)
0.0	4943	0	17757	0	0	0	0	0	0	0	0
0.5	4944	1	20036	1.5	0	0	0	0	0	0	1.5
1.0	4945	2	22023	1.5	0	0	0	0	0	0	1.5
1.5	4946	3	24062	1.5	0	0	0	0	0	0	1.5
2.1	4947	4	26152	1.5	0	0	0	0	0	0	1.5
2.8	4948	5	28293	1.5	26	0	0	0	0	0	27.5
3.5	4949	6	30485	0	26	26	0	0	0	0	52
4.2	4950	7	32728	0	26	26	26	26	0	0	104
5.0	4951	8	35022	0	26	26	26	26	26	0	130
5.9	4952	9	37367	0	26	26	26	26	26	0	130
6.8	4953	10	39763	0	26	26	26	26	26	0	130
7.8	4954	11	42210	0	26	26	26	26	26	0	130
8.8	4955	12	44709	0	26	26	26	26	26	0	130
9.9	4956	13	47258	0	26	26	26	26	26	0	130
11.0	4957	14	49860	0	26	26	26	26	26	0	130
11.0 Acre Feet Storage Required				17 Hours for sump pump to empty pond							

## APPENDIX D: STRUCTURAL WALL SECTIONS





1 SECTION  
CS1 1/8" = 1'-0"



DEPTH WITH OUT  
HYDROSTATIC  
PRESSURE.

DEPTH WITH FULL  
HYDROSTATIC  
PRESSURE.

2 SECTION  
CS1 1/8" = 1'-0"



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MARBLE ARNO STORM DRAINAGE DESIGN  
CONCEPTUAL DESIGN STUDY  
STRUCTURAL RETAINING WALL AND PILE SECTION

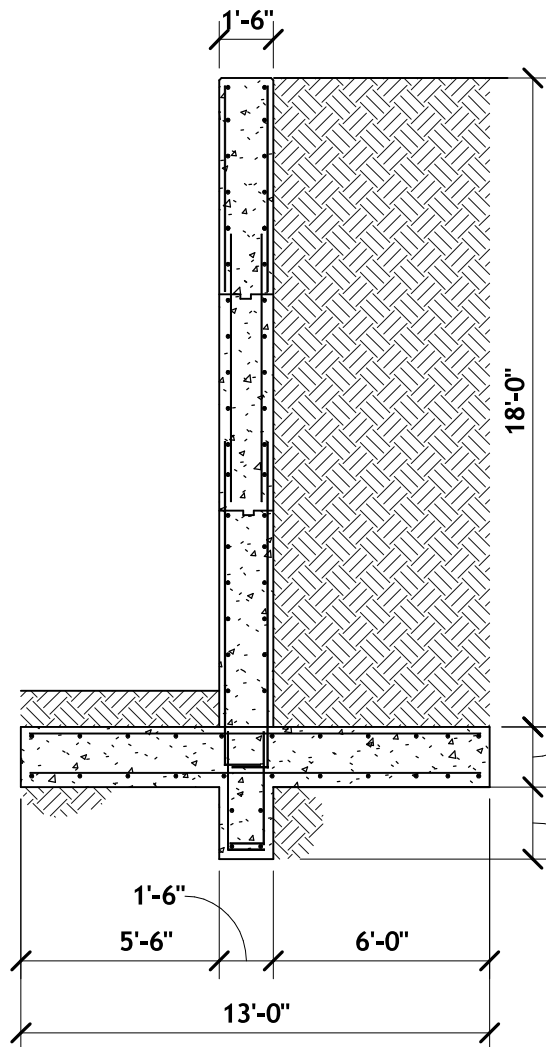
JOB No:  
118102

DATE:  
JUNE 2018

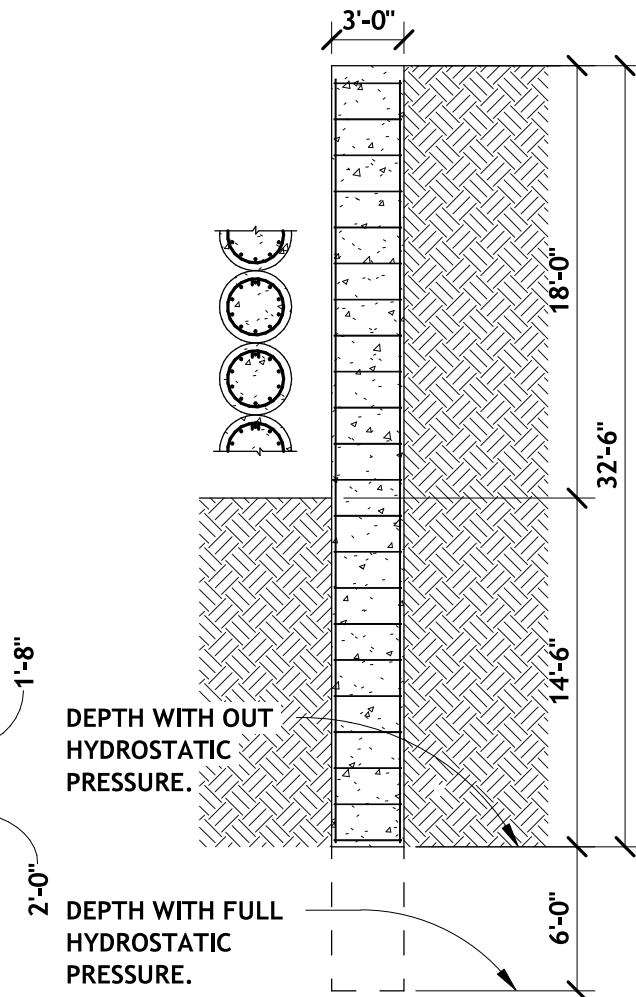
SHEET NO.

CS1





1 SECTION  
CS2 3/16" = 1'-0"



2 SECTION  
CS2 1/8" = 1'-0"



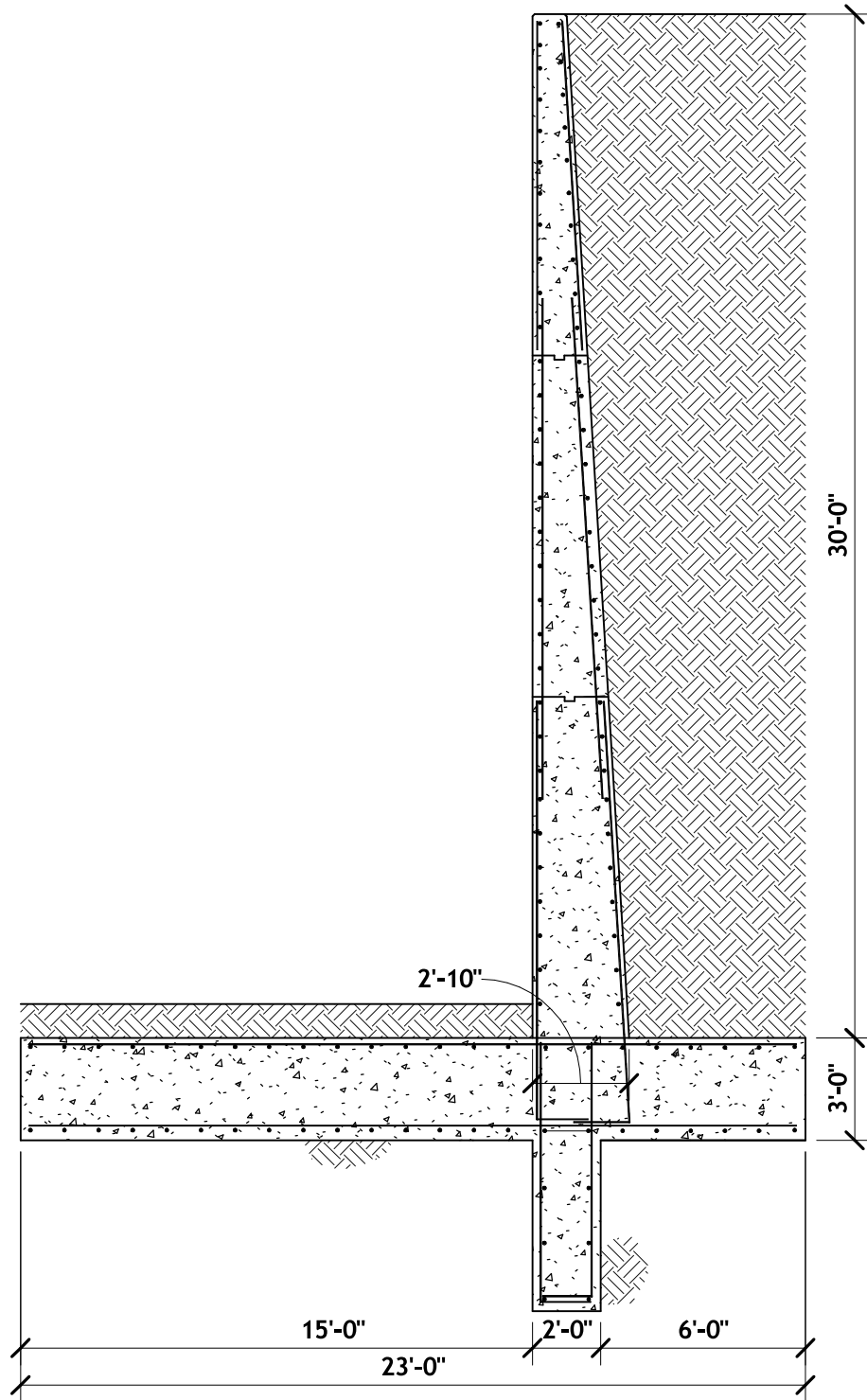
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MARBLE ARNO STORM DRAINAGE DESIGN  
CONCEPTUAL DESIGN STUDY  
STRUCTURAL RETAINING WALL AND PILE SECTION

JOB No:  
118102

DATE:  
06/13/18

SHEET NO.  
CS2



1 SECTION  
CS3 3/16" = 1'-0"



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MARBLE ARNO STORM DRAINAGE DESIGN  
CONCEPTUAL DESIGN STUDY  
STRUCTURAL RETAINING WALL

JOB No:  
118102

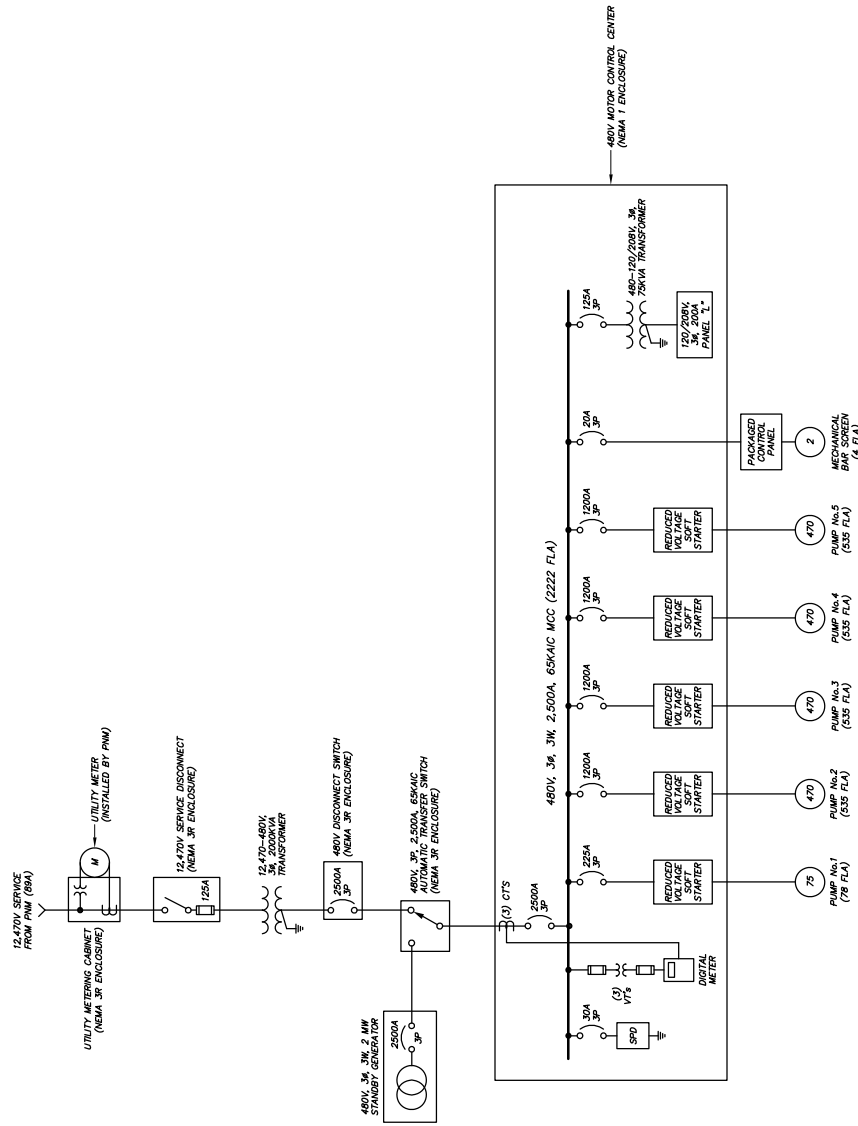
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06/13/18

SHEET NO.  
CS3

## APPENDIX E: ELECTRICAL DIAGRAMS





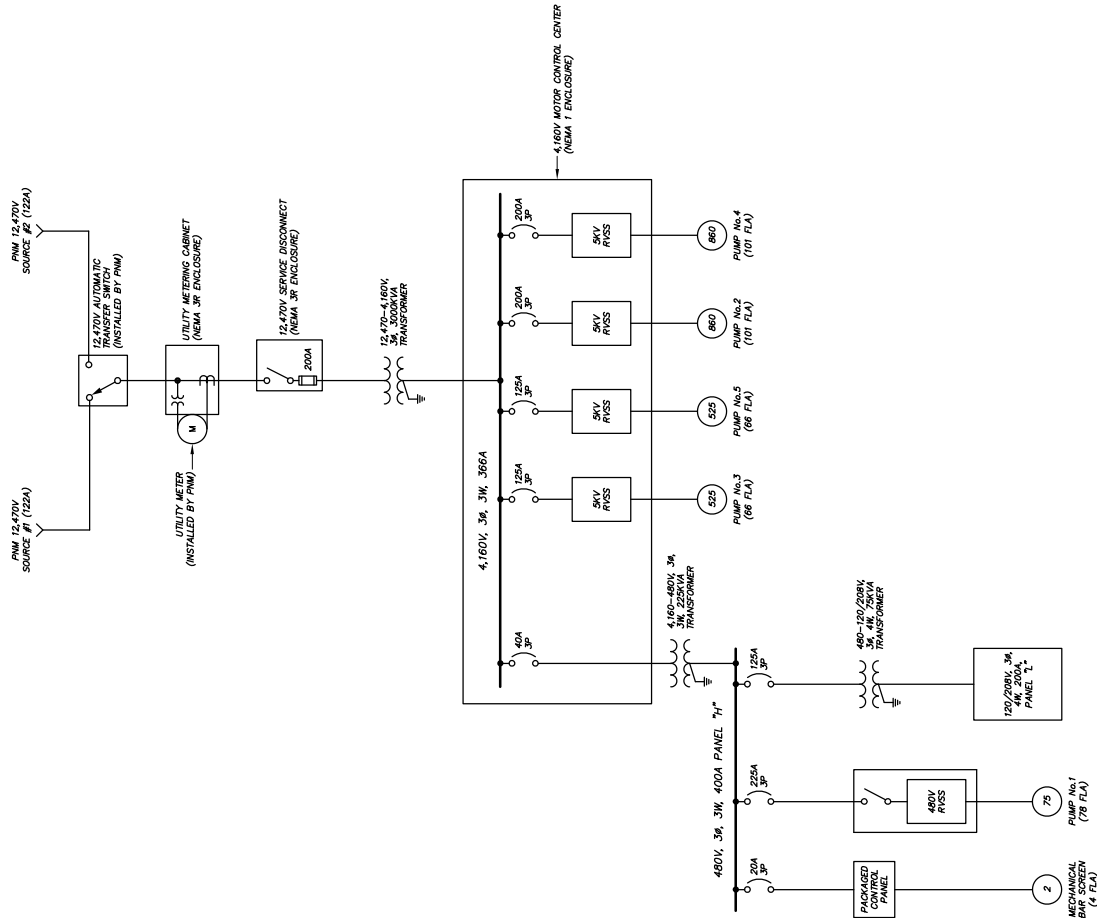


SINGLE SOURCE SINGLE LINE DIAGRAM

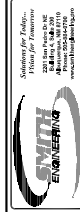


MARBLE ARNO STORM WATER PUMP STATION  
CONCEPTUAL DESIGN  
PUMPING ARRANGEMENT OPTION #1  
SINGLE SERVICE ONE LINE DIAGRAM

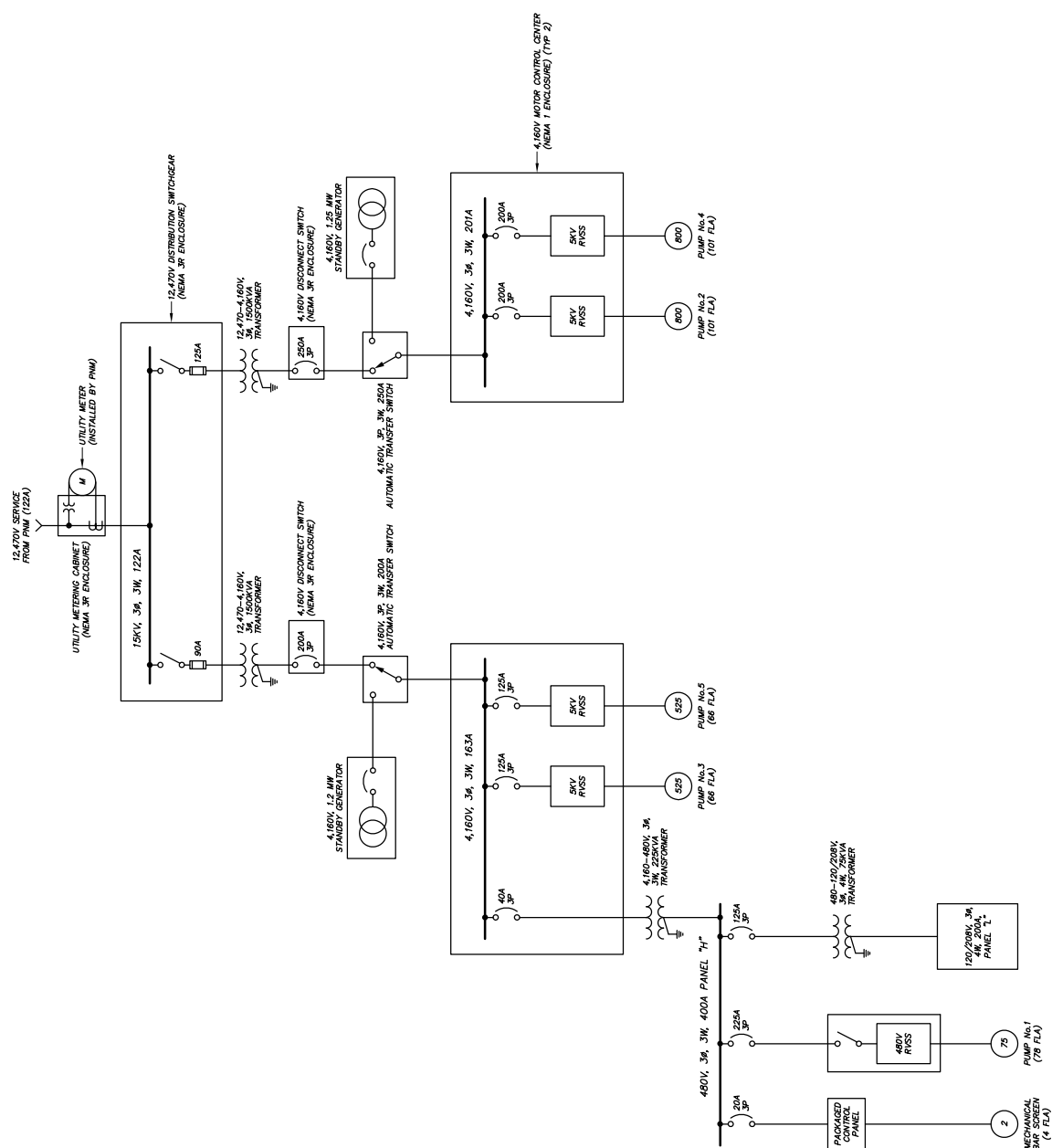
JOB NO.  
118102  
DATE  
7-19-18  
SHEET  
NO.  
ETB



DUAL SOURCE SINGLE LINE DIAGRAM



MARBLE ARNO STORM WATER PUMP STATION CONCEPTUAL DESIGN	JOB NO. 118029
	DATE 7-19-18
PUMPING ARRANGEMENT OPTION #2 DUAL SERVICE SINGLE LINE DIAGRAM	SHEET E2A
	NO.



SINGLE SOURCE SINGLE LINE DIAGRAM



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Utility & Power Distribution  
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MARBLE ARNO STORM WATER PUMP STATION CONCEPTUAL DESIGN		JOB NO. 118022
PUMPING ARRANGEMENT OPTION #2 SINGLE SERVICE ONE LINE DIAGRAM		DATE 7-19-18
		SHEET E2B





