LOCSD Wastewater Connection to City of Solvang
Basis of Design Report- FINAL

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Prepared for:
Los Olivos Community Services District

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Table of Contents

List of Tables

List of Figures

Executive Summary

This report provides design recommendations to the Los Olivos Community Services District (LOCSD) for LOCSD lift stations, storage, and the sewer force main that will connect LOCSD's wastewater collection system to the City of Solvang's. LOCSD requested the force main from their system to Solvang to discourage future connections. The force main system will require approximately 18,000 linear feet (3.4 miles) of pipeline and cross multiple bridges over Alamo Pintado Creek. The proposed point of connection (POC) to Solvang will be at existing sewer maintenance hole (SMH) MD-114, located near the intersection of Ladan Drive and Alamo Pintado Road across from Sunny Fields Park. It is assumed that all Solvang's capital improvement projects described in both the 2021 Solvang Sewer Master Plan (SMP) and Water System Consulting's evaluation to upsize the pipe segments in Solvang's collection system will be completed prior to accepting the wastewater from LOCSD.

Two lift stations are recommended for LOCSD, one on either side of Alamo Pintado Creek. The Grand Ave (eastside) lift station (Grand LS) should be located near the intersection of Grand Ave, Alamo Pintado Rd, and Roblar Ave within the road right-of-way (ROW) ideally located on the northwest corner of the intersection outside of the pavement. The Grand LS helps to avoid a very deep wet well at the Santa Barbara Ave (westside) lift station (Santa Barbara LS). The Santa Barbara LS should be located near the intersection of Santa Barbara Ave and Alamo Pintado Road on the northeast corner outside of the pavement. Due to the existing utilities in the area, the footprint requirements, and access requirements, the Santa Barbara Ave lift station may need to be constructed further back from the road outside of the ROW, which may require an easement from the property owner. Below is a summary of the design recommendations for the two lift stations and associated force mains.

Table ES-1: Summary of Design Recommendations

	Grand Ave (eastside) Lift Station	Santa Barbara Ave (westside) Lift Station
Wet Well Capacity (gallons)	1,250	10,000
Pump Duty Point (gpm)	246.6	334.4
Min. Head Required (ft)	20	15
Odor Control	No	Yes
Generator	Hookups for portable generator	Trailer mounted generator located at site
Site	Designated parking	Driveway access
Force Main Diameter (in)	4	6
Force Main Material	PVC	HDPE

The inclusion of Pressurized Effluent Sewer Systems on the east side of Alamo Pintado Creek, as described in Regen's BODR for the LOCSD collection system, could negate the need for the Grand LS. If the east side of the collection system is pressurized, the collection system may be able to convey wastewater over Alamo Pintado Creek along Santa Barabara County bridge 51C-80 to the Santa Barbara LS. This should be further investigated during final design.

Acronyms / Abbreviations

Acronym / Abbreviation	Full Name
ACI	American Concrete Institute
ADF	Average Daily Flow
ADMMF	Average Daily Maximum Month Flow
ADU	Accessory Dwelling Unit
Ave.	Avenue
ASTM	American Society for Testing and Materials
BOD_5	Biochemical Oxygen Demand
BODR	Basis of Design Report
Cal OSHA	California Division of Occupational Safety and Health
d/D	Depth over Diameter
FT	Feet
GIS	Geographical Information Systems
GPD	Gallons per day
gpm	Gallons per minute
H2S	Hydrogen Sulfide
HDPE	High Density Polyethylene
LF	Linear Feet
LOCSD	Los Olivos Community Services District
max	Maximum
MDF	Maximum Daily Flow
Mg/L	Milligrams per Liter
min	Minimum
MSL	Mean Sea Level
NACE	National Association of Corrosion Engineers
No.	Number
POC	Point of connection
PVC	Polyvinyl Chloride
PWWF	Peak Wet Weather Flow
ppd	Pounds per Day
psi	Pounds per square inch
Rd.	Road
ROW	Right-of-Way
SMH	Sewer maintenance hole
SSPC	Society for Protective
SMP	Sewer Master Plan
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TSS	Total Suspended Solids
WWTP	Wastewater Treatment Plant

1 Introduction and Background

The unincorporated township of Los Olivos is in the Santa Ynez Valley in Santa Barbara County, California. Los Olivos is known for wine tasting, fine and casual dining, and fine art and experiences heavy tourism in the downtown commercial area on weekends and holidays throughout the year. Per the County of Santa Barbara Los Olivos Wastewater Management Plan 2010 (WMP), the daily tourist population is estimated to be two to three times the population of Los Olivos during summer weekends and holidays. Los Olivos has a total of 418 parcels with approximately 350 septic systems per the WMP. There are 391 parcels within the District boundary and the remaining 27 parcels are outside the District boundary located north of Highway 154. The area is a mix of residential and commercial properties with large rural residential, viticulture, and agriculture lots surrounding the downtown commercial area.

In 1974, Santa Barbara County designated Los Olivos a Special Problems Area due to nitrate contamination of the groundwater. Los Olivos is in the Santa Ynez Uplands Groundwater Basin and groundwater monitoring has shown significant impact with the use of septic systems in the Los Olivos area. Properties in Los Olivos currently rely on individual septic systems for wastewater disposal using septic tanks and leach files. There is no sanitary sewer collection system or wastewater treatment facility in the community. The nearest wastewater treatment plant is located approximately 5 miles south in the City of Solvang.

In 2018, to mitigate further groundwater contamination, Los Olivos voters established the Los Olivos Community Service District (LOCSD) to provide a funding mechanism for the building and operation of facilities needed to collect, treat, and dispose of sewage, wastewater, recycled water, and storm water in Los Olivos and adopted resolution 2019-04, the Los Olivos Wastewater Reclamation Program Project (LOWRPP). The LOWRPP is comprised of four components. As part of component no. 4, the District’s goal is to implement a three-phased plan for converting Los Olivos from septic systems to centralized wastewater conveyance, treatment, and disposal facilities:

- Phase I includes the 20-year build-out of the downtown commercial zone which consists of existing commercial properties and neighboring residential properties.
- Phase II includes the residential area to the east and south of Phase I.
- Phase III includes the rest of the community within the Service Area.

It is expected that properties in Phase I and Phase II are expected to be connected immediately after construction of the sewer collection system. Phase III properties are generally expected to be connected when their septic systems fail and may take several years to be connected after the construction of the collection system

1.1 Purpose

The purpose of this report is to document the results of a hydraulic analysis that was conducted to size the sewer lift stations and force mains and provide recommendations to the Los Olivos Community Services District (LOCSD) to connect LOCSD’s future wastewater collection system to the City of Solvang’s existing collection system for treatment at the Solvang Wastewater Treatment Plant (WWTP).

This report presents 30% conceptual design recommendations for LOCSD lift stations, flow equalization storage, and the sewer force main that will connect LOCSD's wastewater collection system to the City of Solvang's.

1.2 Previous Reports

This report utilizes technical findings from prior reports and summarizes the anticipated impacts of the connection to the City of Solvang's wastewater infrastructure. Key references include the following reports:

1. Wastewater Loading Study (Loading Study) by Stantec dated November 19, 2021
2. Wastewater Collection and Treatment Basis of Design Report (BODR) by Stantec dated January 7, 2022
3. Septic to Sewer Project 30% Submittal (Community Gravity Collection System) by Stantec dated June 28, 2022
4. Basis of Design Report Los Olivos Collection Analysis (Hybrid Collection System) by Regen AEC, PLLC dated May 30, 2024.
5. City of Solvang 2021 Sewer Master Plan (SMP) by Water Systems Consulting (WSC) dated November 8, 2021
6. Draft Technical Memorandum for Los Olivos Community Services District Flow Impacts on Solvang Wastewater Treatment Plant by WSC dated October 7, 2024
7. Final Technical Memorandum titled Evaluation of Los Olivos Flows on Solvang WWTP by Carollo Engineers (Carollo) dated November 2024

1.2.1 Los Olivos Previous Analysis

In 2021, Stantec developed the Wastewater Loading Study (Loading Study) that provided estimated average day (ADF), max day (MDF), and peak hour wet weather (PWWF) flows, as well as wastewater quality projections for each phase of the Los Olivos conversion. PWWFs accounts for infiltration of ground water in the conveyance system and inflow of stormwater through storm water connections and openings in the manholes. Although, it is anticipated that dry weather and wet weather flows would be similar in a new collection system. To account for infiltration over the life of the conveyance system and to the affect that tourism in the downtown commercial zone will have, the Loading Study established peaking factors to estimate PWWFs. These peaking factors were established on the basis from previous reports and comparing the existing peaking factors used for the Township of Santa Ynez (SYCSD) and the City of Solvang. Though the community of Los Olivos is like Santa Ynez in that it has a small commercial zone with rural residential, viticulture, and agriculture in the surrounding area and like Solvang with the influx of tourism throughout the year it differs from these nearby towns in population. See Table 1-1 for a summary and comparison of peaking factors used to calculate the PWWF in the Loading Study.

Table 1-1: PWWF Factor Comparison

Design Standard	PWWF Factor
SYCSD Design and Construction Standards	3
City of Solvang Sewer System Management Plan 2015	5
Phase III (Remaining Areas)	4

Table 1-2 and Table 1-3 below summarize the projected flows and wastewater quality for the three build-out phases of the Los Olivos conversion, as estimated by the Loading Study, respectively.

Table 1-2: Los Olivos 20-Year Buildout Flow Projections

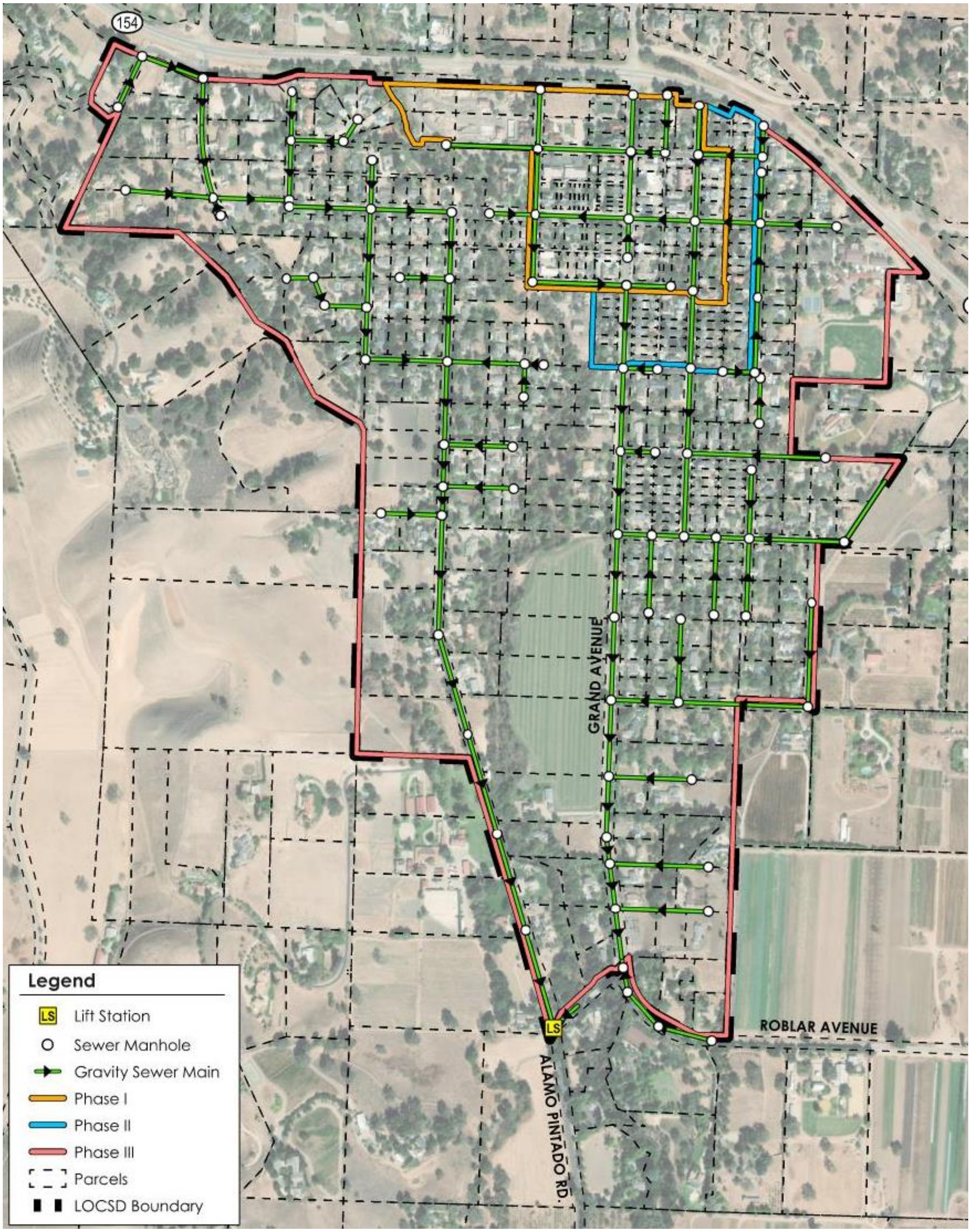
Phase	Average Daily Flow (ADF) (gpd)	Average Daily Flow (ADF) (gpm)	Maximum Daily Flow (MDF) gpd	Peak Wet Weather Flow (PWWF) (gpm)
Phase I (Commercial Zone)	43,800	30.4	140,000	121.7
Phase II (Residential Zone)	54,500	37.9	174,000	151.4
Phase III (Remaining Areas)	117,752	81.8	376,400	327.1
Phase III + ADU (Full Build-Out + Inflow)	120,400	83.6	385,000	334.4

Table 1-3: Los Olivos 20-Year Buildout Wastewater Quality Projections

Phase	Constituent	Average Daily Maximum Monthly Flow (ADMMF) (gpd)	Concentration (mg/L)	Loading (ppd)
Phase I (Commercial Zone)	BOD_5	49,600	769	318
	TSS		493	204
	TKN		99	41
Phase II (Residential Zone)	BOD_5	61,400	658	337
	TSS		437	224
	TKN		88	45
Phase III (Remaining Areas)	BOD_5	133,800	416	464
	TSS		320	357
	TKN		63	70

In 2022, Stantec developed a Wastewater Collection and Treatment Basis of Design Report (BODR) to provide design criteria for a wastewater collection system, sewer lift station, and centralized wastewater treatment facility to serve LOCSD. Figure 1 illustrates the BODR’s preliminary design for the layout of a gravity collection system for LOCSD, assuming the treatment plant’s location is in the southern part of the community, and a sewage lift station, located at the intersection of Alamo Pintado Road and Santa Barbara Avenue. This LOCSD Lift Station was determined to be necessary regardless of the treatment plant’s location.

Figure 1: Los Olivos Preliminary Gravity Sewer Collection Layout



Building upon the BODR, in 2022 Stantec prepared the 30% submittal that included conceptual plans and profiles for the gravity collection sewer system and a conceptual layout of the centralized wastewater treatment facility for LOCSD. The plans included a sewer lift station at the most downstream portion of the collection system to convey wastewater to the centralized treatment facility. This sewer lift station, is referred to as the Santa Barbara Ave. (westside) Lift Station (Santa Barbara LS) in this report, will be located at the north-east corner of Alamo Pintado Road and Santa Barbara Avenue, west of Alamo Pintado Creek.

1.2.2 Solvang 2021 Sewer Master Plan

According to the 2021 SMP, the City of Solvang's wastewater collection system consists of 31 miles of gravity sewer mains and two sewer lift stations (the Fjord and Alisal Lift Stations) that provide wastewater services for 10,230 customers. Wastewater is conveyed to Solvang's WWTP via the Fjord sewer lift station and sewer force main below the Santa Ynez River.

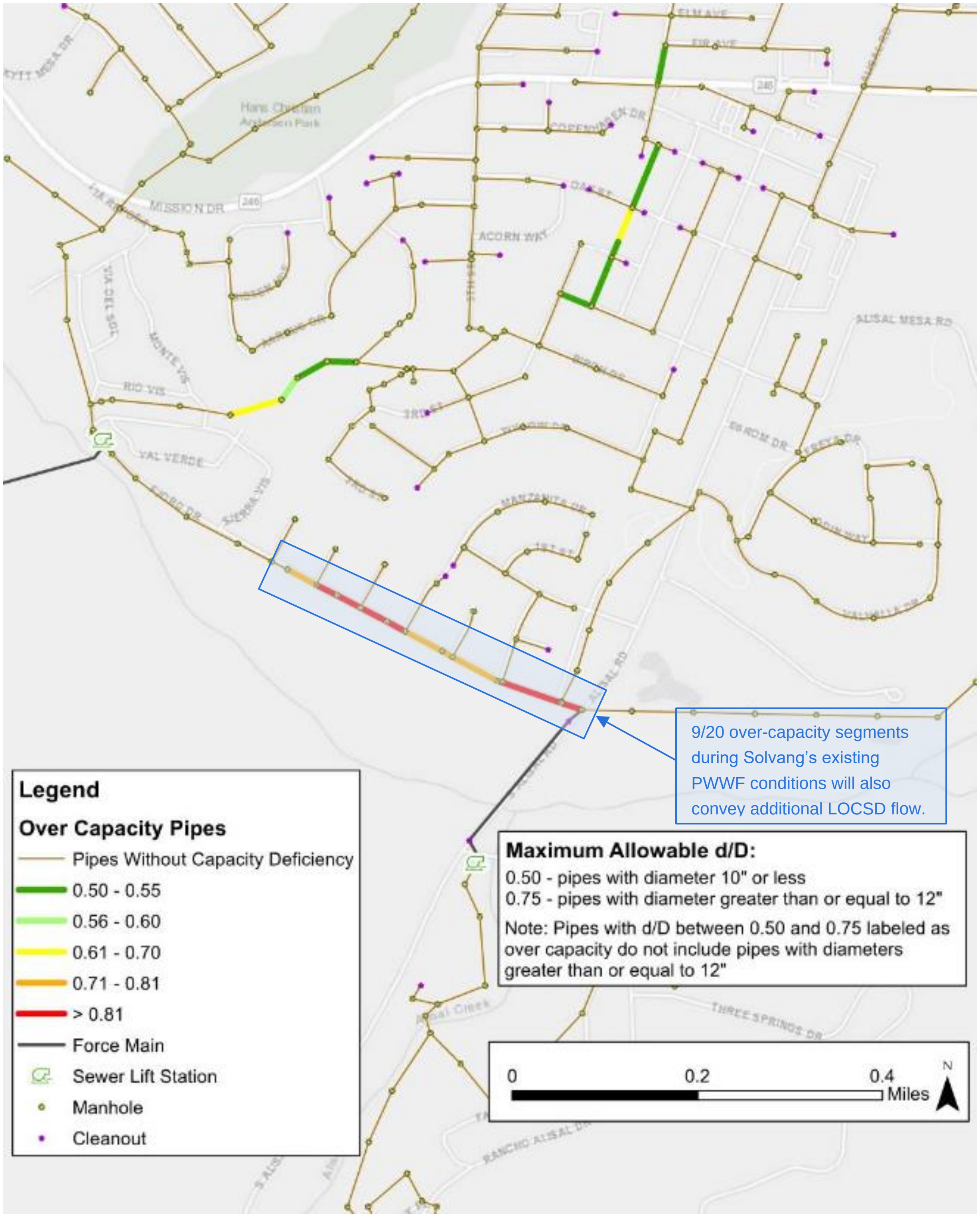
The SMP identified several capacity-related challenges within Solvang's existing wastewater infrastructure. While no pipe segments were found to exceed capacity under annual average flow (AAF) scenarios, 20 pipe segments (0.75 miles) exceeded capacity under peak wet weather flow (PWWF) conditions. See Figure 2 for a summary of the pipeline evaluation criteria used in the SMP.

Of the 20 segments identified, 9 segments (0.33 miles) would convey additional wastewater from LOCSD. These sewer mains are located along Fjord Drive and exceed capacity when the Alisal Lift Station operates during existing PWWF conditions (see Figure 2). The model assumed the peak flow from the lift station coincides with those in the gravity mains, a conservative approach that does not account for pump cycling. No capital improvement projects (CIPs) were recommended to address the capacity constraints as these capacity deficiencies are only present at peak flows and the risk was anticipated to be minimal. The SMP recommended these mains be surveyed to determine if the slopes are as low as Solvang's GIS indicates and that flow be monitored to determine if peak flows are triggering these conditions.

The SMP also evaluated the capacity of the Fjord lift station under various PWWF scenarios. The evaluation concluded that the Fjord lift station has sufficient capacity to handle both existing and future flows under these conditions. As a result, no capacity upgrades were required at either lift station.

Diurnal curves were developed in the SMP using flow monitoring conducted by Utility Systems Science & Software (US^3) at multiple sewer maintenance holes (SMH) through the system. To establish and understand peak flow times within Solvang's wastewater collection system, this report will utilize the diurnal curve and flow monitoring for SMH MD-018, which is along the conveyance route impacted by the addition of LOCSD flow, to establish and discuss peak flow times.

Figure 2: City of Solvang Pipes Evaluation under Existing PWWF Conditions (No LOCSD Addition)



1.2.3 Basis of Design Report for a Hybrid Collection System

In 2024, Regen AEC, PLLC (Regen) prepared a BODR for LOCSD to analyze a hybrid collection system that utilized both a pressurized effluent sewer system and a gravity collection system to collect wastewater from LOCSD. Pressurized effluent sewer systems utilize Septic Tank Effluent Pumps (STEP) and effluent filters to convey wastewater effluent from settling tanks, such as private septic tanks, to a centralized low pressure collection system. The report concluded that pressurized effluent sewer systems tend to have lower infiltration and inflow than gravity sewer collection systems which can reduce the estimated PWWF and may eliminate the need for lift stations. Pressurized effluent sewer systems also contain less solids since the solids are captured by the existing septic tanks. These two factors could eliminate the need for or reduce the size of the wastewater lift stations and is further discussed in this report. The estimated PWWFs within Regen's BODR are not discussed further in this report. The collection system chosen should be considered during final design of the lift stations.

1.2.4 Solvang Wastewater Infrastructure Capacity

In June 2024, LOCSD contracted with WSC to evaluate the impacts of adding the Los Olivos' wastewater to Solvang's collection system. Using the same hydraulic model that was developed for the 2021 SMP, WSC simulated the additional flow by adding a point load to a Solvang maintenance hole located near Sunny Fields Park (see Figure 3). Unlike the SMP, this model only assessed sewer mains that would be impacted by the addition of Los Olivos's flow. Pipe segments that exceeded capacity were taken to mean that the normal depth of flow within the pipeline was greater than the allowable d/D criteria set forth by the City of Solvang sewer design standards. See Table 1-4 for number of pipe segments that exceed capacity with the addition of LOCSD's flow under various flow conditions.

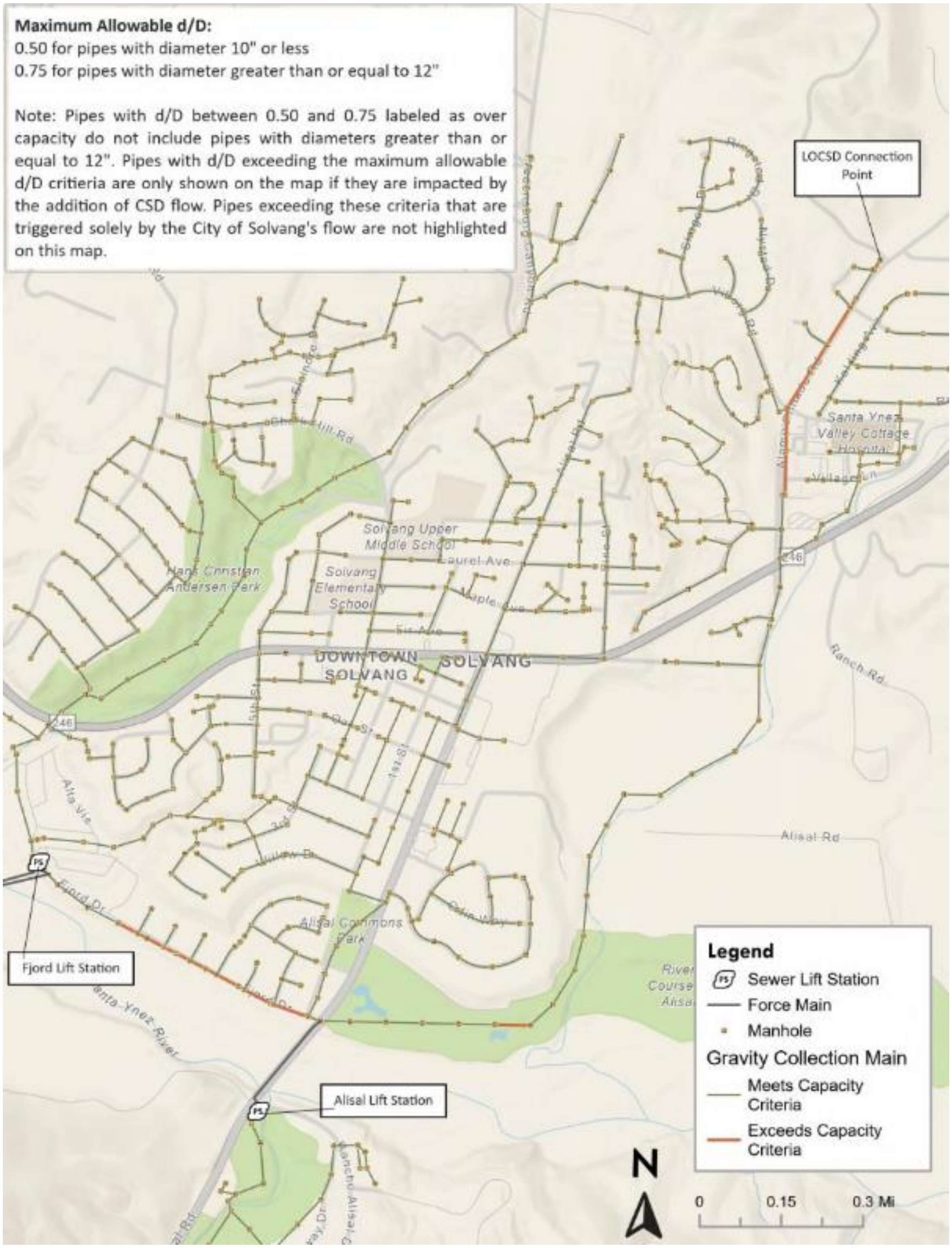
Table 1-4: Pipe Segments Exceeding Capacity under Various Flows and With LOCSD Flow Addition

	Solvang Only		**Solvang + LOCSD**		**Change Due to LOCSD Addition**	
	Number of Segments	Length (miles)	Number of Segments	Length (miles)	Number of Segments	Length (miles)
Existing ADF	0	0.00	0	0.00	0	0.00
Existing PWWF	9	0.32	11	0.43	2	0.11
Buildout PWWF	9	0.32	19	0.87	10	0.55

As previously discussed in Section 0, 9 segments already exceed capacity under Solvang's existing PWWF condition for two primary reasons: (1) they have low (flat) slopes and (2) they only exceed the capacity criteria when the Alisal Force Main is operating. The SMP recommended surveying these mains to confirm slopes and monitoring flows to verify peak flow impacts. Using the SMP's evaluation criteria, WSC determined that while no pipe segments were over capacity-under ADF conditions, the addition of LOCSD's projected PWWF to Solvang's existing PWWF results in 11 segments (two additional segments) exceeding capacity. One of the pipes is another low slope main along the Fjord Drive, while the other is near the proposed connection point where small end-of-line mains constrain capacity.

When comparing the combined flow during buildout PWWF versus existing PWWF conditions, 8 more segments exceed capacity (see Table 1-4). This increase is mainly due to additional demands on end-of-line mains near the proposed connection point (see Figure 3).

Figure 3: City of Solvang Pipes Evaluation under Buildout PWWF Conditions (With LOCSD Addition)



Additionally, there is a section of the trunk main that was identified in the SMP as potentially capacity constrained. To address these deficiencies, WSC proposed four potential capital improvement projects (CIPs). These include increasing the diameter of low-slope gravity mains along Fjord Drive, sections of the trunk main, and end-of-line mains near the connection point. See Figure 3 for a map from WSC's report showing the deficient pipelines that are included in the CIPs.

The capacity of the Fjord Lift Station was also assessed based on the various PWWF scenarios. Results of the lift station capacity evaluation determined the Fjord Lift Station is sufficient to meet the pumping needs of Solvang with the addition of Los Olivos under existing and future buildout scenarios.

1.2.5 Solvang Wastewater Treatment Plant Water Quality

In August 2024, the LOCSD contracted with Carollo to evaluate the impact of connecting Los Olivos' flows to Solvang's WWTP to the water quality of drinking water and wastewater within both service areas. Using a biological process model, Carollo evaluated the scenario where the full Phase III flow and loads would be connected to the Solvang WWTP (see Table 1-3). Even when the simulation was run under the worst-case condition (average daily maximum monthly flow and average wastewater concentrations to simulate the typical highest wastewater loads on the WWTP), the model determined Solvang's future WWTP will be able to effectively meet effluent permit limits (see Table 1-5). However, Carollo's report states that this will only be possible after the WWTP Phase 2 Upgrades project is constructed. The Phase 2 Upgrades project, which is expected to be completed in April 2028, will include reconfiguring the existing sequencing batch reactors and adding secondary clarifiers.

Table 1-5: Solvang WWTP Projected Effluent Concentrations after Los Olivos Connection

Constituent	Constituent Description	WWTP Effluent Permit Limit (mg/L)	Modeled Effluent Concentration (mg/L)
BOD_5(1)	Biochemical Oxygen Demand, 5 days	30	2.4
TSS(1)	Total Suspended Solids	20	4.2
TN(2)	Total Nitrogen	10	8.8

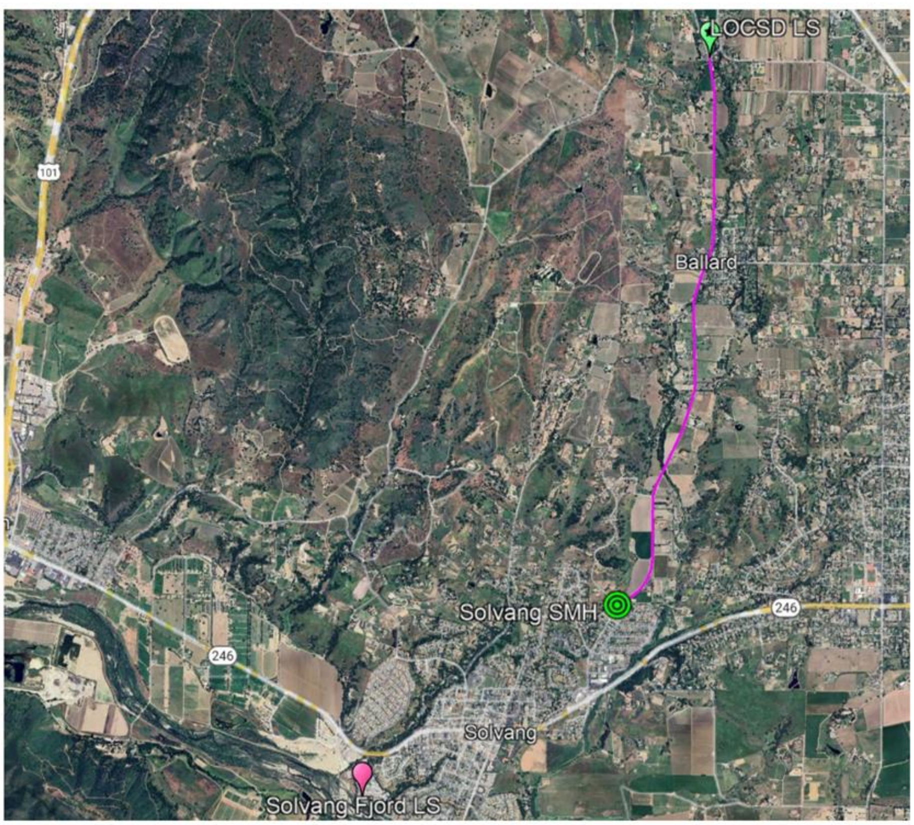
Notes:
(1) 30-day average effluent permit limit provided.
(2) 25-month rolling median effluent permit limit provided.

2 Proposed Preliminary Project

The proposed Project includes a connection from LOCSD LS to the City of Solvang's wastewater infrastructure. This will require approximately 18,000 linear feet (3.4 miles) of pipeline along Alamo Pintado Road and multiple bridge crossings over Alamo Pintado Creek. As shown in Figure 4 below, the proposed point of connection (POC) to Solvang will be at existing SMH MD-114, located near the intersection of Ladan Drive and Alamo Pintado Road across from Sunny Fields Park. While the ground elevation of the proposed location of the LOCSD LS is approximately 751 ft, the Solvang POC has an approximate ground elevation of 510 ft. This decrease in elevation must be considered in the development of the system curve and the design of conveyance system. Gravity flow to the POC, aside from the bridge crossings, is possible with an estimated average downhill slope from LOCSD LS to Solvang's SMH MD-114 being 1.3%. However, LOCSD requested that the pipeline from LOCSD to Solvang be a force main system to prevent connections along the route and account for the bridges.

As noted in the WSC's draft technical memo, the addition of LOCSD's Buildout PWWF to Solvang's Buildout PWWF causes 10 existing sewer mains to exceed conveyance capacity and further inundates 9 sewer mains along Fjord Drive already exceeding capacity at Baseline Existing PWWF. **It is assumed that all CIPs in both the SMP and WSC's evaluation to upsize the pipe segments in Solvang's collection system will be completed prior to accepting the wastewater from LOCSD.**

Figure 4: Los Olivos Lift Station to Solvang Collection System Sewer Force Main Connection



Key components of the Preliminary Project are discussed in the subsections below.

2.1 Sewer Lift Stations

As previously mentioned in Section 1.2.1, the BODR determined a sewage lift station will be required to convey wastewater from the Los Olivos gravity sewer collection system to a wastewater treatment plant regardless of the plant location due to the required depth of the gravity sewer main crossing Alamo Pintado Creek. The 30% conceptual plans showed the gravity sewer system discharging into the LOCSD LS, referred to as the Santa Barbra Ave (westside) lift station (Santa Barbara LS) in this report, to be approximately 25 feet deep at elevation 720.5 ft above MSL. This would require a wet well greater than 25 feet deep to accommodate the incoming gravity sewer main depth.

Tunneling under Alamo Pintado Creek to accommodate a gravity sewer main would require a scour analysis of the creek and trenchless construction roughly 5 to 10 feet below the scour depth. Trenchless construction methods generally could include horizontal directional drilling (HDD), horizontal boring and jacking, or micro-tunneling. Each of these methods have advantages and disadvantages and will require deep excavation pits, greater than the gravity sewer main depth (20 to 25-feet), to facilitate drilling machinery and construction. The assumed length of trenchless construction required is 150 linear feet. The sending and receiving excavation pits could be as large as 30-ft long x 15-feet wide and over 25-feet deep and would require full shut down of the road over Alamo Pintado Creek. Also, a 24-inch to 30-inch casing pipe may be required based on the construction method to house the 10-inch gravity sewer main. The Santa Barbara LS would also require an excavation deeper than 25-ft to allow gravity flow from the collection system to the wet-well structure at Santa Barbara LS. These deep excavations would require adequate shoring designed by a civil or structural engineer registered in California and pose greater risk than shallower excavations. Costs associated with this type of trenchless construction are estimated to be $12,000 to $15,000 per linear foot due to the depth. The advantage associated with a gravity sewer versus a lift station on the east side of Alamo Pintado Creek, are the virtually non-existent ongoing operation and maintenance costs. A lift station would require ongoing operation and maintenance cost throughout the entirety of its useful life.

An additional lift station on the east side of Alamo Pintado Creek to capture the flow from the eastside of the collection system will avoid a deep wet well at Santa Barbara LS and trenchless construction below Alamo Pintado Creek. This report focuses on the additional lift station, referred to as the Grand LS on the east side of Alamo Pintado Creek. The sewer force main from this lift station could attach to the downstream side of the existing Santa Barbara County bridge # 51C-80 crossing Alamo Pintado Creek to discharge into the Santa Barbara LS on the west side of the creek. The Santa Barbara LS would pump the wastewater to the Solvang sewer collection system. Figure 5 shows the two lift stations on either side of Alamo Pintado Creek.

Figure 5: Proposed Sewer Lift Stations

The inclusion of a wet well at each lift station is critical for regulating inflow and ensuring consistent and efficient operation. Additionally, the pressurized sewer force mains system enabled by the lift stations provides several advantages, such as minimizing the size and depth of pipelines which reduces construction costs and limiting further development along the Alamo Pintado Road. As a concept, it is assumed that the lift stations will consist of a round maintenance hole style wet well with duplex submersible pumps. One pump shall be for duty service and the other for redundancy, with alternating duty service.

The inclusion of pressurized effluent sewer systems as described in Regen's BODR for the LOCSD collection system, could negate the need for the Grand LS or the need for trenchless construction below Alamo Pintado Creek for a gravity sewer main. The pressurized effluent sewer system has all of the advantages of the sewer force main system described for the Grand LS. If the east side of the LOCSD collection system is pressurized within a low-pressure sewer system, this low-pressure sewer could be hung along bridge 51C-80 over Alamo Pintado Creek to convey the wastewater effluent to the Santa Barbara LS granted that the pressure system is sized appropriately. This option may have economic advantages for LOCSD if the Grand LS doesn't need to be constructed but may pose risk as there would be no hold over storage on the east side during maintenance or repairs of the pressurized effluent sewer systems that the Grand LS would provide. This should be analyzed during final design based on the collection system chosen for LOCSD.

See Table 2-1 for a summary of the eastside collection system options discussed for comparison purposes.

Table 2-1: Eastside Collection System Options

Option	Eastside Collection System	Construction Method at Alamo Pintado Creek	Eastside Lift Station Required (Y/N)	Additional Operation and Maintenance Costs	Estimated Additional Construction Costs
1	Gravity Sewer System	Trenchless	N	N	$2,500,000
2	Grand LS with force main	Hanging on Bridge	Y	Y	$500,000
3	Pressurized Effluent Sewer System	Hanging on Bridge	N	N	0$

The operation and maintenance costs and additional construction costs shown in Table 2-1 analyze the portion of the collection systems near the Grand LS location up to the Santa Barbara LS and do not include any other portions upstream or downstream of the collection systems including the Santa Barbara LS. Each option will require the construction of the Santa Barbara LS and associated conveyance piping to the Santa Barbara LS which is considered the baseline cost. There may be other operation and maintenance costs, and other construction costs associated with other portions of the collections system that are not included in this report but should be investigated prior to final phase.

The options show in in Table 2-1 are highly depending on the collection system chosen by LOCSD. Based on the estimated additional costs, the option that poses the most economic advantage to LOCSD is option 3, the pressurized effluent sewer system to Santa Barbara LS. Option 3 would require the collection system to be a pressurized effluent sewer system. Though option 2, providing a lift station at Grand LS, provides hold over storage incase maintenance is required, it is more costly than option 3 but can be utilized with a pressurized effluent system or gravity collection system. Option 1 is the most costly due to the nature of trenchless construction and deep excavations required and it is estimated that the ongoing operation and maintenance cost for the expected life of the Grand LS would be less than the construction costs for option 1.

2.1.1 Sewer Lift Stations Site Layouts

The lift station sites generally consist of a ‘level’ graded area that is large enough to accommodate the power system, standby generator building or hookups, control panels, wet well structure, and valve vaults with setbacks around these items to provide adequate space between items and for access and maintenance, and to meet federal, state, and local code requirements. Based on the location of the lift station sites there will need to be adequate space for vehicle parking due to the proximity to the public road. The sites will need to be graded to allow adequate storm water drainage away from the sites as well. It is recommended to provide fencing around the perimeter that will restrict access and block view from the public ROW. The site layouts will be included in the 30% design plans.

The Grand LS should be located near the intersection of Grand Ave, Alamo Pintado Rd, and Roblar Ave within the road right-of-way (ROW). The ideal location is on the northwest corner of the intersection outside of the pavement as shown in *Figure* 6. A parking space adjacent to the lift station is needed for maintenance personnel. The lift station needs to accommodate the existing fire hydrant, 8-inch water main, communications maintenance hole, and electrical box within the ROW.

Figure 6: Proposed Grand Ave LS Location

The Santa Barbara LS should be located near the intersection of Santa Barbara Ave and Alamo Pintado Road on the northeast corner outside of the pavement. Due to the existing utilities in the area, the footprint requirements, and access requirements, the lift station may need to be constructed further back from the road outside of the ROW, which may require an easement from the property owner. The existing 8-inch water main that crosses behind the existing power poles, may need to be relocated to fit the wet well and maintain adequate clearances between the water and sewer.

Figure 7: Proposed Santa Barbara Ave LS Location

2.1.2 Lift Station Structure

The lift station structures will consist of a cylindrical concrete wet well to collect the incoming wastewater from the gravity collection system. The wet wells will house a pumping system to discharge the wastewater to a desired endpoint. The wet well will be supported by a monolithic thickened concrete foundation and have a top slab with locking access hatch prevent sewage gases from escaping and prevent unauthorized access.

2.1.2.1 Materials

Sewer lift stations are typically constructed from reinforced concrete which is lined with products that meet the Society for Protective Coatings (SSPC), National Association of Corrosion Engineers (NACE), American Concrete Institute (ACI), and American Society for Testing and Materials (ASTM) codes and standards. These coatings protect the interior of the wet well from the corrosive environment caused by the wastewater and are typically made from epoxy or acrylic. The concrete is designed specifically for water-retaining with a compressive strength of 4,000 psi or greater. The lift station structure, concrete mix, lining and coatings should be specified during final design. The concrete cylindrical barrels of the list station can be precast concrete or cast-in-place, but the precast concrete is typically cheaper and faster to construct than cast-in-place.

The other option is for the wet well to be constructed from fiberglass. Fiberglass tanks can be manufactured with a double-wall, leak detection, and to resist most chemicals and gasses so a lining is not required. However, fiberglass is not as widely available, and there can be restrictions on the full size and shape of the fiberglass structural components. The maximum inside diameter is 12 feet. The fiberglass tanks typically arrive as a single, easy to install unit.

2.1.2.2 Shoring, Bedding, and Backfill

Per Cal OSHA and California Code of Regulations*,* all excavations greater than 5-feet in depth will require adequate shoring which must be designed by a registered California Structural or Civil Engineer. The excavation for the wet wells will require an excavation approximately 15 feet deep. Adequate shoring to protect the workers, the structures, and the surrounding soil during construction of the sewer lift station will be required.

The construction of the lift station structure will also require proper compaction of the underlying soil to achieve an unyielding foundation for the sub-base and concrete base foundation. During final design, a Registered California Geotechnical Engineer should be retained to conduct a field investigation and analysis of the surrounding soils and provide recommendations for horizontal and vertical loading of the soil, seismic parameters, required soil compaction, shoring, depth to groundwater, drainage, and backfill among others. These recommendations should be used during the final design of the sewer lift station structure, trenching, excavation, compaction, and backfill.

2.1.2.3 Groundwater and Buoyancy Forces

The preferred lift station sites are located approximately 180 to 220 feet from Alama Pintado Creek indicating there may be groundwater present. Recent ground water monitoring at the Grand LS site conducted by LOCSD indicated that groundwater is present from 8 to 10 below the ground surface. During final design, a Registered California Geotechnical Engineer should be retained to conduct a field investigation and analyze the proximity to groundwater at both lift station locations and provide recommendations for the buoyancy forces and soil pressure due to ground water that can be used when designing the lift station structures.

2.1.2.4 Minimum Sizing and Dimensions

Typically, the dimensions for sewer wet wells are designed based on pump sizes, maintenance, incoming peak flow, retention time, pumping system flow rate, and desired on and off pump cycling. For this project, the following equations were used to size the wet wells for each lift station.

$$Vmin = [Tmin * Qout]/4$$

$$Vmin = minimum\ volume\ of\ fluid\ between\ pump\ cycles$$

$$Tmin = minimum\ time\ between\ pump\ cycles$$

$$Qout = pump\ discharge\ rate$$

The pump discharge flow rates meet the PWWF (Qout) of the collection systems discharging to the respective wet well. See Table 2-2 for minimum wet well volume (Vmin) summary for each lift station.

Table 2-2: Minimum Wet Well Volume

	Qout (gpm)	Tmin (minutes)	Vmin (gallons)
Grand LS	246.6	20	1,250
Santa Barbara LS	334.4	60	5,000

Based on the calculated minimum required volume, the initial dimensions of the wet well can be established. Using an iterative process, the nominal diameter of the wet well is chosen, and the corresponding depth and incoming sewer depth is analyzed while keeping in mind excavation depths, constructability, and site constraints. For this project, structure depths were approximated down to the minimum submergence. The minimum submergence is the depth of fluid required above the pump impeller which is typically designated by the pump manufacturer and is not included in this report. The maximum level of the wastewater in the wet well was kept 1-ft below the incoming sewer invert to avoid surcharging the incoming sewer. The incoming sewer invert into the wet well was based on sloping 0.5% from the upstream gravity collection system maintenance hole to the lift station. See Table 2-3 for a wet well dimension summary.

Table 2-3: Wet Well Dimensions

	Wet Well Diameter (ft)	Incoming Sewer invert depth (ft)	Liquid Depth (ft) based on Vmin	Approx. Wet Well Depth (ft)
Grand LS	8	7.65	3.28	11.95
Santa Barbara LS	12	5.30	5.93	12.25

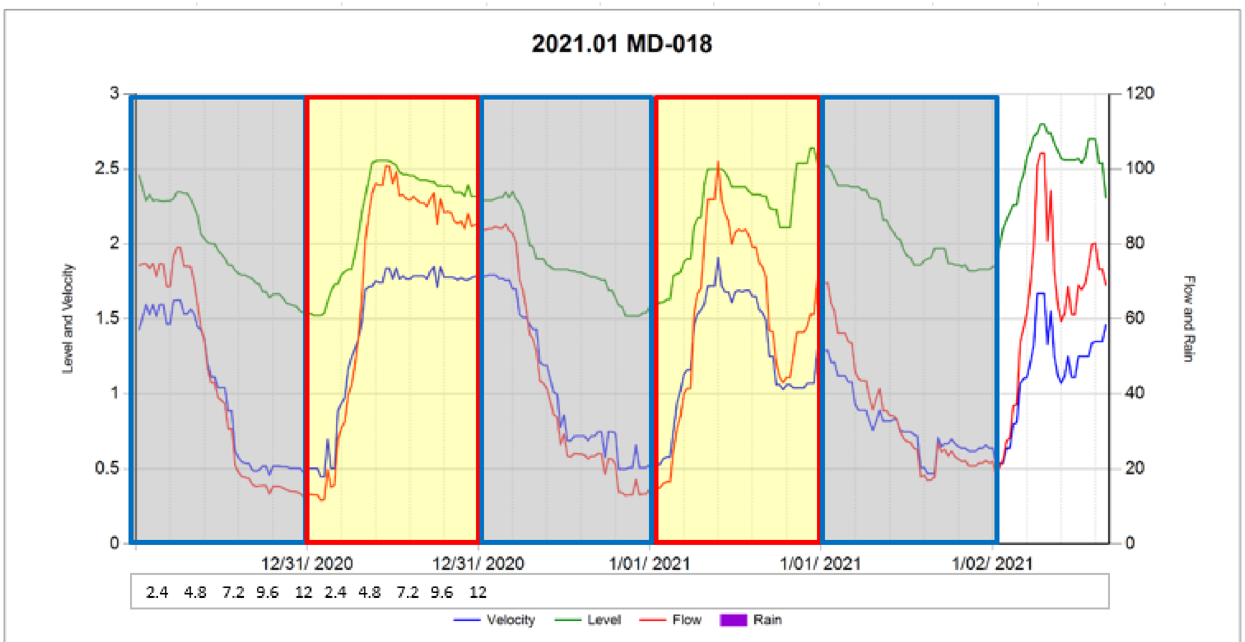
2.1.2.4.1 Flow Equalization Storage

Flow equalization storage involves holding a specified volume of liquid and using a pumping system to discharge at a desired flow rate. This is helpful to minimize pump cycling and discharge wastewater at desired times throughout the day. Each wet well has a specified storage volume and a pumping system to allow for flow equalization. Additional flow equalization storage beyond the volume of the wet well is not necessary for the Grand LS as this will be discharging to the Santa Barbara LS. Additional flow equalization storage volumes, flow rates, and feasibility for the Santa Barbara LS is further discussed below.

It would be ideal to send wastewater during the low flow periods in Solvang's collection system. This would help avoid overloading Solvang's collection system but is not entirely necessary if the proposed CIP's for Solvang's system are constructed. The proposed CIP's in WSCs report concluded that upsizing the deficient pipeline segments will handle both buildout PWWF's from Solvang and LOCSD simultaneously, therefore, PWWF from LOCSD can theoretically be sent at any time of the day.

Diurnal curves were developed for Solvang's existing SHM MD-018 via flow monitoring and documented in the SMP. This existing sewer manhole is along the conveyance path that would accept flow from LOCSD. Based on these curves, it is estimated that there is, on average, a 7-hour window of low flow from 7:30 pm to 2:30 am. The other 17 hours in this report are referred to as the 'high flow' window. Figure 8 shows the diurnal curves for SMH MD-018.

Figure 8: Solvang SMH MD-018 Diurnal Curve from SMP



	Velocity (fps)	Level (in)	Flow (gpm)		
Average	1.123	2.123	51.058	RainFall	Inches
Maximum	1.910	2.800	104.210		
Minimum	0.449	1.520	11.670		0.030

2/17/2021

It is assumed that the diurnal flow pattern for LOCSD collection system will mimic the developed diurnal curves for Solvang's collection system based on the similarities for the wastewater types (e.g. residential, commercial) at buildout. It is estimated that 90% of the daily flow within LOCSD's collection system will be generated during the 17-hour high flow window. It is likely that flows during the weekend days will be higher than flows during the week due to the influx of tourism in the downtown commercial area of Los Olivos on the weekends.

To send wastewater from the Santa Barbara LS to Solvang during the low flow window only, a majority of the daily wastewater collected from LOCSD would need to be stored at the Santa Barbara LS. The travel time from the Santa Barbara LS to Solvang's collection system would take approximately 90 minutes (1.5 hrs). Therefore, it would be possible for the wastewater pump to turn on 1.5 hours prior to the low flow window (i.e. 6:00 pm). The minimum storage required for the buildout ADF of 124,000 gallons and considering the travel time, would be approximately 94,000 gallons (124,000 gallons – 334 gpm*90 mins).

Based on the site constraints, there is limited space for additional storage within the ROW at the Santa Barbara LS. The 94,000 gallons does not provide enough storage for flows higher than the ADF. As an example, during the estimated MDF, it would take a single pump running continuously for 19.2 hours to discharge 385,000 gallons of wastewater indicating that wastewater would need to be sent during high flow periods as well. Storing 94,000 gallons is only 25% of the MDF. If we are to assume that 90% (346,500 gpd) of the MDF would be generated during the 17-hour high flow window this would equate to an average of 20,380 gph. The wastewater stored at the lift station would reach 94,000 gallons within 5 hours of the high flow window and the pumping system would need to turn on and would most likely require both pumps running at the same time discharging higher flow than the PWWF into Solvang's collection system. Though the MDF is seldom expected, it should be noted that flow above the PWWF of 334.4 gpm was not modeled in WSC's report and it is unknown what effect this will have on Solvang's existing and proposed (with CIPs) collection system capacity. See Table 2-4 for a discharge summary during the low flow window.

Table 2-4: Low Flow Window Storage Volume Discharge Summary

LOCSD Buildout Scenario	GPD	Single Pump Flow (gpd)	Pump ON Duration Required based on 334.4 gpm (hrs)	Can be sent during Low Flow Window Only (Y/N)
ADF	124,000	334.4	6.2	Y
MDF	385,000	334.4	19.2	N

In contrast, if there is no additional storage, during an average day at buildout, it is estimated that the pump will turn on every hour for 20 minutes and be off for 40 minutes during the 17-hour high flow period. Pump cycling every hour satisfies minimum general recommendations, but any flows higher than the buildout ADF would require a single pump to run longer, cycle more often, or both pumps running simultaneously.

Another factor in analyzing the storage volume is residence time, or the amount of time the wastewater is sitting stagnant. Storing wastewater for 17 hours as described is not recommended and comes with many challenges, including settlement of sludge, formation of H2S gas, and odor control issues due to the wastewater becoming septic. Per LOCSD request for storage, Stantec recommends holding wastewater for no more than 6 hours. This includes holding flow generated during low flow periods where it is expected that only 10% (12,400 gallons during buildout ADF) of the flow would accumulate. As previously established, it is impractical and not necessary to store a large volume of wastewater at the Santa Barbara LS and send during the low flow window to Solvang, but some additional storage is useful. An additional wet well of the same size, hydraulically linked to the primary wet well would allow for roughly 10,000 gallons of storage, while maintaining pump cycling of less than 6 hours during buildout ADF. A single pump would turn on 6 to 7 times during the high flow window and run for an average of 45 minutes.

Per LOCSD request, additional downstream storage near Sunny Fields park was considered. This would provide additional holdover storage which could allow flow to be sent within desired time but there would still be no way to avoid sending flow during the high flow window for flows greater than MDF. This additional storage would also require an additional lift station at this location to discharge the stored wastewater to Solvang. There would also need to be an odor control system in place due to the nature of storing the wastewater. This option is not recommended.

This report assumes that all CIPs in both the SMP and WSC's evaluation to upsize the pipe segments in Solvang's collection system will be completed prior to accepting the wastewater from LOCSD. However, if the CIPs are not constructed, storing a wastewater volume greater than the buildout ADF and sending it only during the low flow window is not feasible.

2.1.2.5 Access/ Hatches

The length and width of the access hatch for a duplex wet well structure should be large enough to accommodate removal of both pumps on their rail systems. The pumps are horizontally separated a specified distance from one another to avoid a vortex and from competing with one another while both are operating. This separation distance is typically specified by the pump manufacturer. The access hatch should be rated for H-20 traffic loading and be constructed of aluminum or coated steel.

2.1.2.6 Odor Control

The proposed Santa Barbara Ave (westside) sewage lift station should include an odor control system due to the proximity to residential areas and potential of longer storage times during periods of low flow. The odor control solution can be assessed during final design. A biofilter or carbon scrubber along with aeration are likely the preferred odor control solution.

The proposed Grand Ave LS does not need to include an odor control system since the wastewater can be pumped out of the wet well without time restrictions and the lift station does need additional storage.

2.2 Wastewater Pumps

2.2.1 Pump and Impeller

Typically, wastewater pumping systems are designed as a duplex system, with a lead pump and a lag pump. Both pumps should be sized to handle the PWWF alone and should be rated the same so they can be cycled and work together efficiently during periods of high flow. For this project, a duplex system will be utilized for both the Grand LS and Santa Barbara LS.

Wastewater pumps within wet well structures are submersible and placed at a specified dimension above the wet well bottom with no inlet piping before the impeller. There are various designs for impellers based on the necessary application of the pumping system, fluid being pumped, maintenance, and reliability. It is typical in residential and commercial wastewater pumping systems to specify a non-clog impeller to allow the passage of solids of 2” – 3” in diameter. See Table 2-5 for a summary of the minimum pump requirements.

Table 2-5: Minimum Pump Requirements

	Flow (gpm)	Head (ft)
Grand LS	246.6	20
Santa Barbara LS	334.4	15

The head shown in Table 2-5, is the minimum head required for these pumping systems to overcome at the given flow rate. The head includes the static lift from pump impeller to point of connection and the headloss generated from friction in the sewer force main piping, which is further discussed in section 2.3. The head required is not necessarily the output of the pumping system. The output of the pumping system is depending on the pump curve provided by a pump manufacturer specific to the selected pump. This should be specified during final design.

2.2.2 Minimum Submergence

Minimum submergence is the depth of fluid above the impeller that the pump must have for proper operation and to avoid a vortex from forming in the fluid which could cause cavitation at the impeller. This fluid level in the wet well is specified by the pump manufacture and can be maintained by the set points of the control system.

2.2.3 Power Requirements

For submersible pumps, the pump motor should be submersible as well. The motor is typically manufactured with the pump itself as a single unit. The motor should be sized to drive the pump impeller at speed required to produce the operating flow and pressure. Based on the pump requirements described previously, motors of this size require 3 phase power at 208 to 480 volts alternating current, 480 Volts being more desirable.

As discussed further below in section 2.3.3, a variable frequency drive (VFD) will be necessary to drive the pump motors at the Santa Barbara LS at the desired flow rate while operating within the limits of the pumping system. The VFD may require air conditioning and/or adequate exhaust and venting and should be analyzed during final design.

To provide power to the pumping system, the power feed source should be located and analyzed. It is typical to have a local transformer installed onsite that can transform the power from the power source up or down to the desired voltage for the pumping system. The power is delivered via a service panel, to the breaker panel, control systems and components, and other auxiliary uses such as site lights and alarms.

During final design, the power to the site and pumping system should be designed by a Registered Electrical Engineer.

2.2.4 Backup Power

The Santa Barbara LS will include a standby generator, either diesel or natural gas to allow continued operation through power outages. The power distribution panel will be fitted with an automatic transfer switch to avoid manual switching of power sources. Per the request of LOCSD, the generator will be mounted on a trailer and regularly located at this lit station. A trailer mounted generator has a less stringent permitting process through the County of Santa Barbara Air Pollution Control District (APCD). It is recommended to construct a building to house the trailer mounted generator to protect it from the elements, screen it from the public, and security purposes.

The Grand LS needs to include a hookup for the potable standby generator in case of a power outage. The hookup should be located so that it is accessible to the standby generator without the use of long conductors.

For discussion purposes, during a power outage where both lift stations are without power, each lift station could have its own dedicated generator. it is also possible to run both the Santa Barbara LS and Grand LS from a single generator. This would require conductors to be ran along the same alignment as the sewer force main from the Grand LS to the Santa Barbara LS which includes mounting on the downstream side of the bridge over Alamo Pintado Creek. The conductors would need to be sized to adequately deliver the required power from the generator to the Grand LS. The standby generator itself would also need to be sized to handle the required locked rotor start up loads and all other loads at both lift stations simultaneously.

The generator set should be designed by a licensed electrical engineer during final design.

2.2.5 Instrumentation and Controls

2.2.5.1 Control System

The control system is vital to the operation of the pumping system and is typically located at the lift station. It receives and provides signals to automatically operate and protect the pumping and other systems as well as provide alarms. The control system is typically equipped with a local control panel with interface and Programable Logic Controller that is used to turn on and off the pumps at specified set points and control other systems. These systems normally have Hand-Off-Automatic settings based on the desired operation. The control system uses the output signals from various instruments for automatic operation of the pumping system and other systems such as an aeration or odor control system. It is typical for control systems to come packaged with the pumping system designed and integrated by the pump manufacture. The control system, if specified, can be integrated with HMI devices and/or SCADA devices and software for remote operation and data collection.

As discussed further in section 2.3, the wastewater pumps in the Santa Barbara LS may need to be controlled by an integrated frequency convert or variable frequency drive (VFD) due to the downhill nature from lift station to point of connection. The VFD will be part of the controls system and can drive the pump to discharge at a specified flow rate regardless of the head required by the system. By reducing or increasing the power frequency using control programming, the VFD can reduce or increase the rotational speed of the pump impeller to discharge at the desired rate. The control system including the VFD should be specified during final design.

2.2.5.2 Level Measurement

It is typical to have multiple systems for liquid level measurement in the wet well for redundancy. Typically pressure transducers and level float systems are used to measure the liquid level in the wet well and provide a feedback signal to the control system for level control. There are various types of pressure transducers that are used in wet wells to provide fluid level data back to the control system. Some common types include hydrostatic and ultrasonic level transducers. Hydrostatic types can be submerged and mounted to the side or the bottom of the wet well. They use pressure on an internal sensor diaphragm to relay an analog signal back to the control system. Ultrasonic level transducers can be mounted above the fluid, non-contact, and use ultrasonic pulses to the measure down to the fluid and relay a signal back to control system. Level floats can either be used as the primary or secondary level measurement system. The level float systems use floats on top of the liquid connected to a cable to measure the high level and low level within the wet well and turn the pump on or off or trigger alarms. Each system has its advantages and disadvantages depending on the fluid in the wet well.

For this project, it is recommended to have an ultrasonic level transducer mounted above the fluid as the primary level measuring system and float system as the secondary system. Ultrasonic level transducers provide high accuracy measuring, are easy to install, are easy to access, and reduce maintenance because they are not submerged. It is anticipated that the incoming wastewater will have a low percentage of fats, oils, and greases due to the predominantly residential flows. Fats, oils, and greases become a concern when they accumulate and form a layer at the top of the wastewater which can provide false reading when using an ultrasonic level transducer.

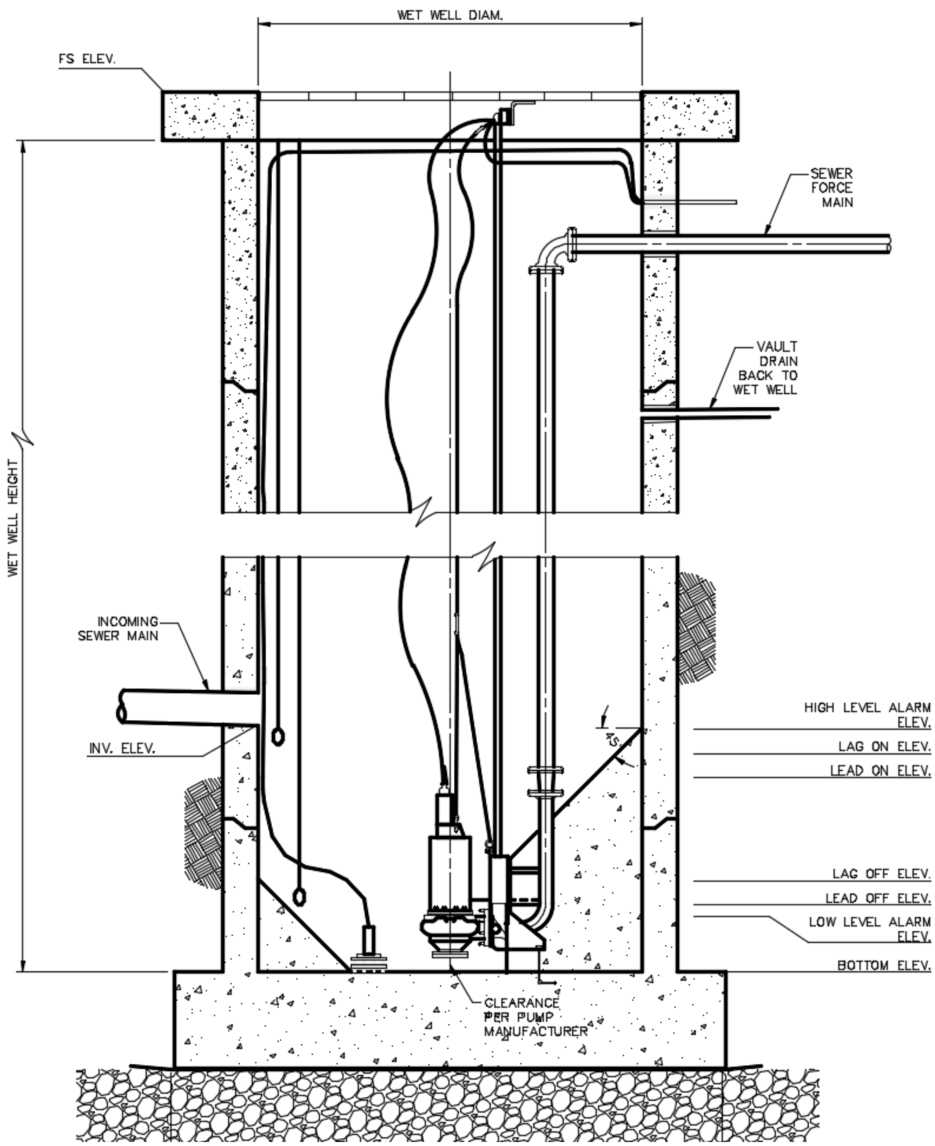
2.2.5.3 Set Points

Set points are the liquid levels within the wet well that trigger various functions with the control system. These liquid levels are programmed into the control system and are triggered when the continuous signal from the level measuring system in the wet well measures these levels. Common set points for wet well operation are:

- Minimum Submergence (discussed previously) at low level alarm
- Low level 1 (lead pump OFF)
- Low level 2 (lag pump OFF)
- Lead Pump ON
- Lag Pump ON
- High Level Alarm

See Figure 9 for typical set points within the wet well.

Figure 9: Set Points Example



2.2.6 Discharge Header

The discharge header from the pumping systems consists of vertical piping up through the wet well that typically penetrates the wet well side wall at a desired elevation. This elevation is dependent on various factors but typically is at the depth of the sewer force main below the ground surface. For this project the force main will be a minimum of 4 feet below the ground surface. The discharge piping will be separate from each pump, will continue to a buried valve vault where they will converge to a single force main. Prior to convergence, the discharge mains will have combination air release and vacuum valves to exhaust air at pump start up, allow accumulated air to leave the pipeline during operation, and intake air to avoid vacuum conditions when the pump(s) turn off. Inside the valve each discharge main will be equipped with check valves for back flow prevention and plug valves for isolation.

2.2.7 Valve Vault

The valve vault structure is typically a pre-cast rectangular reinforced concrete structure buried in the ground to accommodate the depth of the discharge piping. Inside the valve vault, each discharge main will be equipped with check valves for back flow prevention and plug valves for isolation. It is also recommended to install a magnetic flow meter after the discharge mains converge for measuring the flow of the wastewater inside the force main. The valve vault should be large enough to accommodate the piping, valves, meters, and appurtenances and allow for proper operation and maintenance of these items. As discussed further below, force main size for this Project is recommended to be 6" and 4" for the Santa Barbara LS and Grand LS, respectively. This will require an approximate 6-foot x 8-foot vault structure with 3-foot x 4-foot double leaf lockable access hatch for both lift stations. The valve vault should also have a floor drain with a pipe that slopes back to the wet well in case there is any leakage or incidental storm water inside the vault.

2.3 Sewer Force Main

Sewer force mains are pipelines that convey pressurized wastewater to a discharge point using a pumping system. Typically, sewer force mains are constructed using pipeline materials such as ductile iron pipe (DIP), high density polyethylene (HDPE), or polyvinyl chloride (PVC). These materials have advantages such as long useful life, high flow capacity, constructability, and corrosion resistance. Using these materials allows for traditional pipeline construction with restrained joints and prefabricated fittings. Table 2-6 shows the general advantages and disadvantages for each pipeline material.

Table 2-6: Pipeline Material Advantages and Disadvantages

Pipeline Material	Advantages	Disadvantages
DIP	• Rigid (for shallow depth and above ground applications) • Simple construction	• Lots of joints • Requires restraining at key locations
HDPE	• Fully restrained with virtually no joints • Very flexible with a small bending radius for horizontal and vertical bending (25*OD) • Can be install via trenchless methods	• Requires special fusing equipment during construction and repairs • Not recommended for above ground applications
PVC	• Simple construction • Somewhat flexible; can incorporation horizontal and vertical bending (250*OD)	• Lots of joints • Requires restraining at key locations • Not recommended for above ground applications

Sewer force mains typically reduce the size and depth of sewer mains and, in general, decrease the cost of construction compared to a gravity system. Sewer force mains are primarily used when a discharge point in the wastewater system is at a higher elevation than the collection point of the system. This includes crossings along bridges. The Project includes two bridge crossings that require the use of a sewer force main. It is also understood that utilizing a pressurized pipeline for the entire alignment may discourage any future connections in the surrounding area.

2.3.1 Alignment

The proposed alignments for the sewer force mains from Grand LS and Santa Barbara LS will follow public rights-of-way to minimize disruptions to private property and streamline construction. As previously mentioned, the sewer force main conveying wastewater to the City of Solvang, referred to as SFM-1, will begin at the Santa Barbara LS located at the intersection of Alamo Pintado Road and Santa Barbara Avenue and extend to the proposed POC (MD-114) at Solvang's wastewater infrastructure. Along the alignment, the pipeline will cross Alamo Pintado Creek via two bridge crossings. For the SFM-1 alignment, there is an option to use trenchless construction for runs up to 1000-ft and below the creek crossings. Utilizing trenchless construction such as HDD can reduce the construction duration, minimize construction costs, and is less invasive than traditional open cut trenching. This would require the use of seamless flexible pipe such as HDPE. However, trenchless construction requires specialized equipment and specialized construction crew to perform the work. The excavations for the sending and receiving pits may require shoring designed by a registered civil or structural engineer.

Trenchless construction below the creek crossings would require jurisdictional permits and may require a scour analysis of Alamo Pintado Creek to determine an adequate depth for the boring. It is recommended that the pipelines be hung along the downstream side of the bridges to avoid drilling below the creek crossings. This would require approval from Santa Barbara County. Hanging the pipeline along the bridges would require structural design of supports and brackets and it is recommended to use fully restrained rigid pipe such as ductile iron.

The sewer force main from the Grand LS to Santa Barbara LS, referred to as SFM-2, will be routed across Alamo Pintado Road and mounted to the downstream side of Bridge 51C-80 over Alamo Pintado Creek and terminate at Santa Barbara LS wet well. Because of the relatively short length of SFM-2, trenchless construction doesn't provide significant advantages over open-cut trench construction so it is recommended to utilize open-cut trenching when outside the creek.

2.3.2 Pipeline Sizing

Sewer force mains are typically sized by analyzing the hydraulics, maintaining desired velocities, and anticipating maintenance requirements. To properly analyze the hydraulics, a system curve must be established. The system curve is dependent on the frictional characteristics of the pipeline material and appurtenances, the length of piping, and elevation information. For this Project, this report will assume that the discharge flow rate through the force main is equal to the PWWF which equates to 334.5 gpm and 246.6 gpm for the Santa Barbara LS and Grand LS, respectively. For two pumps in operation, the maximum flow rate is assumed to be doubled, but this is highly dependent on the actual pump curve and the system curve. Typical design velocities within sewer force mains range from 2 to 8 feet per second (fps) during normal operation to convey solids while also minimizing the risk of scouring of the pipeline. For this Project, velocities will be held below 6 fps while a single pump is on, and below 12 fps when two pumps are discharging. To estimate the force main sizes required to maintain these velocities during operation, we will use the following equation:

$$A\ (area) = \frac{Q(flow)}{V\ (velocity)}$$

$$A\ (area) = \frac{334.4\ gpm}{4\ fps} * \frac{1\ ft3}{7.48\ gallons} * \frac{1\ minute}{60\ second} = 0.1864\ ft2$$

$$D, (diameter) = \sqrt{Area} * \frac{4}{\pi} = 0.4872\ ft = 5.9\ inches$$

Table 2-7 shows the pipeline material, friction coefficient, and pertinent hydraulic information used in to analyze the sewer force main for the Santa Barbara LS. The cost per linear foot (LF) is the construction costs for the pipe that includes the pipe material, installation, and construction method.

Table 2-7: Santa Barbara LS Force Main Material Comparison

Pipeline Material	Nominal Size (inches)	Inside Diameter, I.D. (inches)	Hazen-Williams Friction Coefficient, C	Velocity (fps)	Design Flow (gpm)	Cost / LF
DIP Class 50 (40 mils ceramic epoxy lined)	6	6.32	130	3.34	334.4	$300/ LF
HDPE DR 21	6	5.96	140	3.85	334.4	$300/ LF
PVC CL165	6	6.31	145	3.43	334.4	$250/ LF

Table 2-8 shows pipeline material, friction coefficient, and pertinent hydraulic information used in to analyze the sewer force main for the Grand LS.

Table 2-8: Grand LS Force Main Material Comparison

Pipeline Material	Nominal Size (inches)	Inside Diameter, I.D. (inches)	Hazen-Williams Friction Coefficient, C	Velocity (fps)	Design Flow (gpm)	Cost / LF
DI Class 50 (40 mils ceramic epoxy lined)	4	4.30	130	5.45	246.6	$280/LF
HDPE DR 21	4	4.05	140	6.15	246.6	$280/LF
PVC CL165	4	4.39	145	5.22	246.6	$230/LF

This report recommends using PVC for the Grand LS sewer force main due to the material availability, open-cut trenching recommendation, future maintenance and repair considerations, and cost per linear foot. For the Santa Barbara LS force main it is recommended to use HDPE due to the long pipeline length, minimal joints required, the construction could utilize HDD as necessary, and HPDE has a short bending radius that is optimal for the bridge transitions and meeting necessary clearances from crossing utilities

2.3.3 Hydraulic Analysis

A hydraulic analysis was conducted to initially size the wastewater pumps within the sewer lift stations and the sewer force mains. Based on the friction losses caused by the velocity through the pipelines, bends, and appurtenances as well as the elevation data along the alignment of the pipeline, a system curve was developed. Specifically for the Santa Barbara LS, the system curve developed through the 6-inch pipeline shows that approximately 116 ft of headloss is generated and the elevation difference from the Santa Barbara LS to SMH MD-114 is -219.75 ft. See Table 2-9 below for a hydraulic summary of each pumping system.

Table 2-9: Hydraulic summary

	Flow (gpm)	Pipe Size (in)	Length (ft)	Start Elev. (ft)	End Elev. (ft)	Friction Loss (ft)	Min. Head Required (ft)
Grand LS	246.6	4	475	738.11	742.50	13	20
Santa Barbara LS	334.4	6	18,000	733.75	514.00**	116	15*

*Since the friction loss gradient is less than the elevation gain gradient from Santa Barbara LS to Solvang's SMH MD-114, the required head shown is the head required to lift wastewater from wet well to discharge piping.
**Assumed elevation of SMH MD-114, point of connection to Solvang's collection system.

The grade change from the Santa Barbara LS to Solvang's SMH MD-114 has an average downhill slope of 1.2%. The elevation difference from the Santa Barbara lift station to any point along the pipeline is greater than the friction loss within the pipeline at the specified flow rate. This means that gravity can convey the fluid from the Santa Barbara LS to the point of connection without additional pressure from the pumping system. There are multiple localized high points along the alignment due to the natural terrain, two bridge crossings, and the static lift required to get the wastewater from the wet well to the discharge piping, that warrant a pressurized sewer.

In general, pumps will operate where their pump curve meets the system curve. Because of the downhill nature of the system, the pump(s) within the Santa Barbara LS may operate off their curves as the system doesn't require additional head to covey the fluid. A pump operating off its respective curve can lead to overcurrent which could damage the motor. To avoid pumping beyond the limits of the pumping system, sufficient head needs to be applied against the pump so it operates on its curve, or the pump should be equipped with speed control, such as a variable frequency drive (VFD), to meet the desired flow rate regardless of the system head required. Utilizing a VFD can be adjusted to accommodate lower flows that may be expected during the weekdays and while phases of collection system are constructed.

Possible solutions to apply head against the pump include reducing the pipeline size and/or providing standpipes along the alignment. It is impractical to reduce the pipe sizing for portions of the pipeline due to any high-capacity needs for flows beyond the PWWF. Also, applying sufficient head through a series of standpipes would lead to multiple portions of stagnant wastewater and would require multiple air release and odor control stations along the pipeline which may require significant maintenance. The most desired option is to equip the pumping system at Santa Barbara LS with a VFD.

2.3.4 Isolation Valves

An important aspect of sewer force main conveyance systems is to provide regularly spaced and strategically located gate or plug valves for isolation of pipeline segments to allow for maintenance or repairs without having to drain large portions of the force main. It is common practice to place isolation valves every 1,250 to 1,500 linear feet (LF) for long straight runs and at the upstream and downstream segments at bridge crossings.

The sewer force main from Santa Barbara LS will be approximately 18,000 LF and will require a minimum of 14 isolation valves along the pipeline and 4 isolation valves at the two bridge crossings for a total of 16 isolation valves.

The sewer force main from Grand LS to Santa Barbara LS will be approximately 475 ft and require a minimum of 4 isolation valves, one of either side of the bridge and one for each pump discharge force main in the valve vault.

2.3.5 Wastewater Combination Air Release and Vacuum Valves

Another important aspect to pressurized conveyance systems is to minimize that amount of accumulated air within the pipeline during operation. Large pockets of air caused by pumping and / or dissolved air in the fluid can accumulate at high points along the pipeline alignment and cause a reduction in flow. To purge the pipeline of accumulated air, air release valves are strategically placed at localized high points along the alignment and at the discharge headworks of the pumping system. In addition to purging accumulated air, there may be a need to intake air to allow gravity flow and/or break a syphon and to exhaust a large amount of air during start up. To achieve this, combination air release and vacuum valves specifically made for wastewater applications will be used. These valves are equipped with a combination of large orifice and float valve to intake/exhaust large volumes of air as well as a smaller air release valve to continually release accumulated air during operation. In addition to localized high points, these valves are typically placed along the pipeline at long horizontal runs and changes in slope. These valves will be incorporated along the established pipeline alignments during the preliminary design phase.

3 Design Recommendations Summary

Below is a summary of the design recommendations for the Project.

Table 3-1: Summary of Design Recommendations

	Grand Ave (eastside) Lift Station	**Santa Barbara Ave (westside) Lift Station**
Wet Well Capacity (gallons)	1,250	10,000
Pump Duty Point (gpm)	246.6	334.4
Min. Head Required (ft)	20	15
Odor Control	No	Yes
Generator	Served from Santa Barbara LS	Trailer mounted generator located at site
Site	Designated parking	Driveway access for parking
Force Main Diameter (in)	4	6
Force Main Material	PVC	HDPE