San Luis Obispo County
Los Osos Wastewater Project Development

TECHNICAL MEMORANDUM

EFFLUENT REUSE AND DISPOSAL ALTERNATIVES

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San Luis Obispo County
Los Osos Wastewater Project Development

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1.0 INTRODUCTION

The purpose of this technical memorandum (TM) is to evaluate reuse and disposal alternatives for the proposed Los Osos wastewater treatment facility as discussed in the Viable Project Alternatives Fine Screening Analysis (Carollo Engineers, August 2007). This TM is intended to provide further information and a more detailed analysis on effluent reuse and disposal alternatives to support the Environmental Review Process.

Potential reuse and disposal alternatives carried forward from the Fine Screening Analysis are sprayfields, leachfields, wetlands, agricultural reuse and urban/landscape irrigation reuse. This TM further develops these potential reuse/disposal alternatives by identifying sites, development and maintenance requirements, and institutional/implementation issues. The pipeline routing and requirements from the new treatment facility to the disposal sites are also discussed. Since none of the reuse/disposal alternatives have adequate year round capacity by themselves, they are combined into project configurations to provide full disposal capacity year round. These project configurations are discussed with respect to their capacity, seasonal flows, winter storage requirements, water quality issues and costs.

2.0 BACKGROUND

The community of Los Osos, California is located on the central California coast adjacent to the Morro Bay State and National Estuary. The community's water is supplied entirely by its underlying groundwater, predominately the lower aquifer. The lower aquifer is presently experiencing seawater intrusion at approximately 460 acre-feet per year (AFY). The portions of the aquifer that have already been intruded are likely permanently lost from the freshwater supply.

The community currently relies on septic tanks for wastewater disposal. However, the Regional Water Quality Control Board is requiring the community to implement collection and treatment of the wastewater due to the high density of septic systems that has contributed significantly to nitrate contamination of the upper aquifer. The discharges from the residents' septic tanks currently provide mitigation for seawater intrusion on the order of 90 AFY. Collection of the wastewater flows will increase the seawater intrusion problem from 460 AFY to 550 AFY, unless mitigated. Given the threat of seawater intrusion to the sustainability of the community's water supply, the reuse/disposal alternatives have been compared based on their potential benefits in terms of mitigation of seawater intrusion.

2.1 Seawater Intrusion Mitigation

Mitigating seawater intrusion has been identified as the principle benefit with which to compare reuse and disposal options. The Fine Screening Analysis established configurations based on different levels of seawater intrusion mitigation:

- Level 1 - maintain seawater intrusion at current levels by mitigating the impacts from the project of 90 AFY (removal of septic discharges to the groundwater basin).
- Level 2 - provide the maximum level of seawater intrusion mitigation possible for the wastewater project without significant water purveyor participation (190 to 240 AFY).
- Level 3 - provide mitigation for the current level of seawater intrusion with septic system collection (550 to 600 AFY). Mitigation projects will require purveyor participation.

It is anticipated that the environmental analysis will review the options with the largest degree of seawater intrusion mitigation that can be achieved by the wastewater project alone, which is equal to approximately 190 to 240 AFY. Therefore, only Level 2 options will be evaluated in this TM.

As discussed in the Fine Screening Analysis, different reuse/disposal alternatives provide different levels of seawater intrusion mitigation. The mitigation factor (MF) describes the ratio of seawater intrusion mitigated per volume of effluent reused or disposed with a particular alternative. Figure 1 shows possible locations of potential reuse/disposal alternatives and their accompanying MFs. In general, more seawater intrusion mitigation is obtained as production is reduced in lower aquifer wells on the west side of the basin closer to the leading edge of seawater in the aquifer. In the Fine Screening Analysis, Level 2 projects involved sprayfields and leachfields at Broderson, and some of the projects involved a small degree of urban/landscaping irrigation reuse and agricultural reuse.

2.2 Capacity Needed for Disposal

Reuse and disposal alternatives were discussed in detail in the Fine Screening Analysis. The Fine Screening Analysis did not take wet weather flows into account to size the capacity of the disposal alternatives. In this TM, an average annual flow of 1,290 AFY is used to size the disposal alternatives. The projection of 1,290 AFY reflects a population of 18,428 at buildout consuming 66 gallons/person/day, leading to a dry weather flow of 1,363 AFY before conservation, and wet weather infiltration into the collection system of 83 AFY (0.3 million gallons per day [mgd] for three months per year). This projection also assumes implementation of a conservation program to retrofit the community with low flush toilets which is assumed to save approximately 160 AFY (1,363 + 83 - 160 = approx. 1,290).

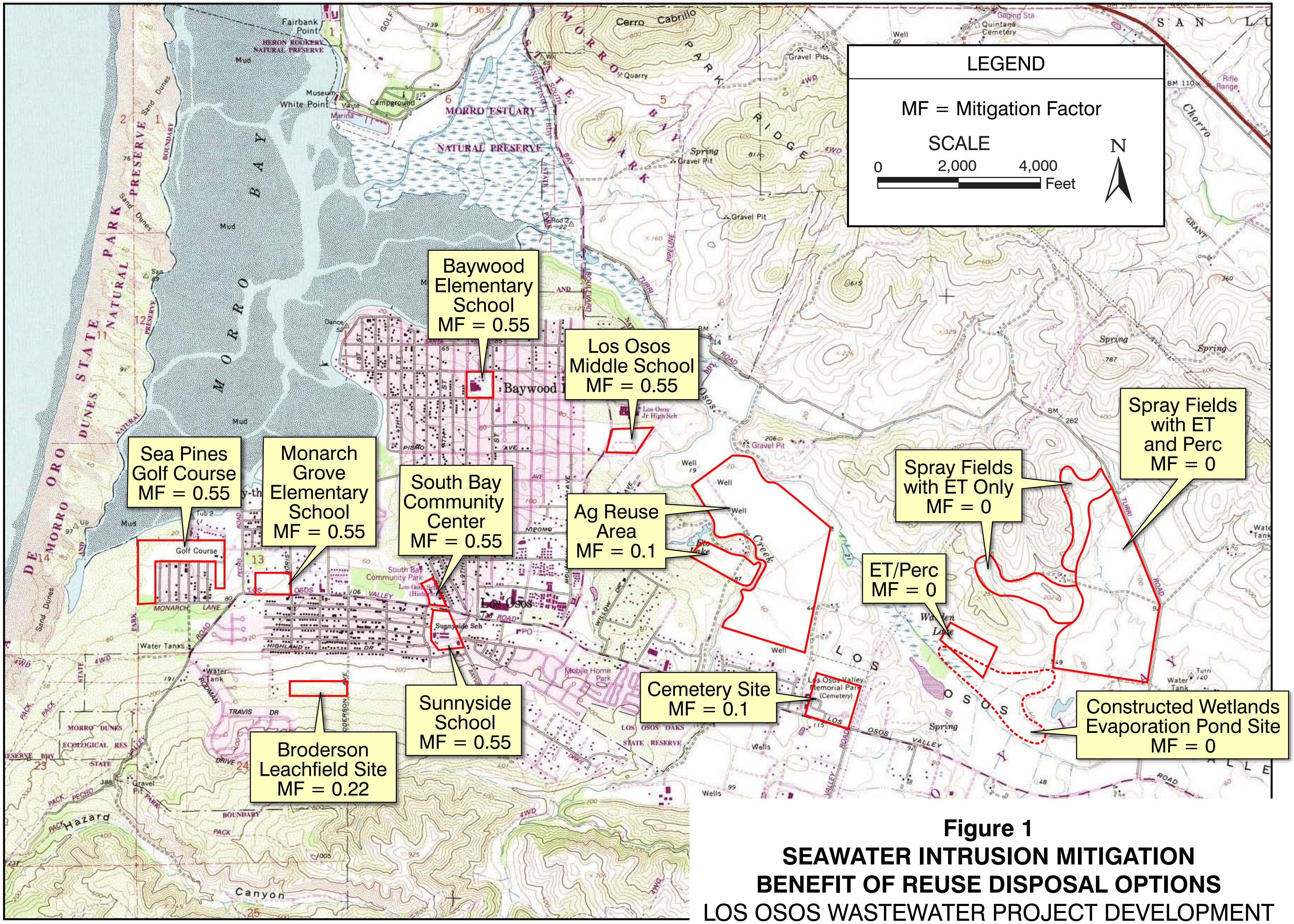

Figure 1
SEAWATER INTRUSION MITIGATION
BENEFIT OF REUSE DISPOSAL OPTIONS
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

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Because no reuse/disposal alternative has enough capacity to accept the entire 1,290 AFY effluent flow, different alternatives must be combined to make a complete reuse/disposal project.

2.2.1 Sensitivity

The initial startup flows are expected to be approximately 960 AFY, which reflects the water use of the current population with conservation and without wet weather infiltration. Because the initial flows will be lower than the projected flows at buildout, there will be time once the project begins to refine reuse/disposal strategy if either the estimates of disposal flows or the estimates of reuse/disposal site capacity are too high or too low.

3.0 ANALYSIS OF REUSE/DISPOSAL ALTERNATIVES

Each reuse/disposal alternative presented in the Fine Screening Analysis is developed in more detail in this TM in terms of siting, design and construction requirements, maintenance and operations requirements, and implementation issues.

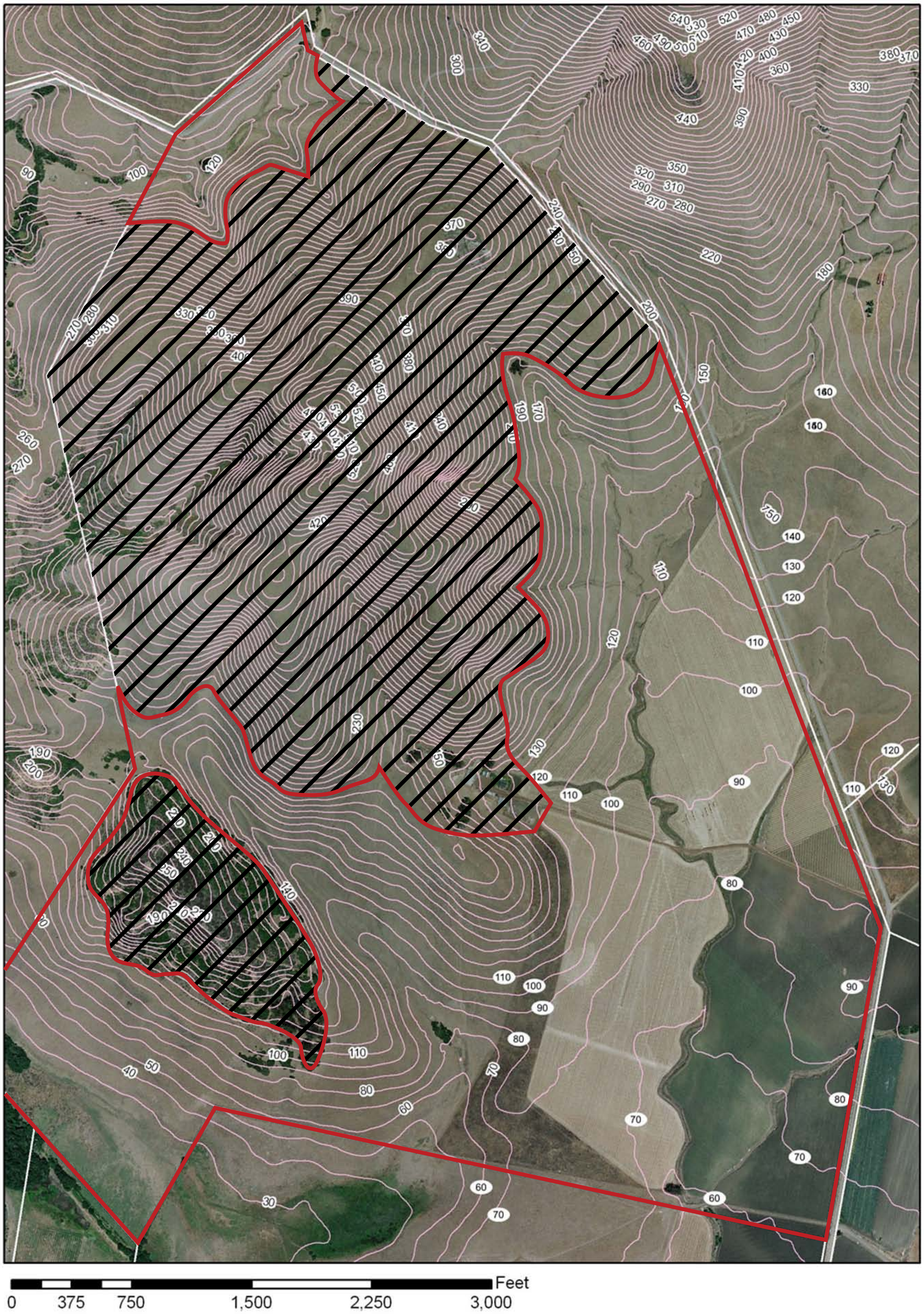
3.1 Spray Fields

Spray field disposal is the practice of spraying effluent on land to dispose of the water through evapotranspiration and percolation. While grasses are grown on sprayfields, no particular crop is grown for harvesting, which would be termed reuse. Sprayfield disposal would likely require secondary treatment with disinfection.

Sprayfields would be operated to maximize evaporation and minimize runoff. This entails spraying only during the daytime and collecting any tail water and returning it to the sprayfields for reapplication. Depending on the site that is selected for sprayfields, disposal will occur by evapotranspiration, or by both evapotranspiration and slow-rate percolation. Selection of sites with soils characterized by slow-rate percolation potential will allow for a higher disposal capacity and less area requirements than a site with only evapotranspiration capabilities (no percolation).

3.1.1 Potential Sites

Tonini Ranch (shown in Figure 2) continues to be the primary site under consideration for spray field disposal because it is a large parcel that is currently for sale, and is located close to many of the sites under consideration for location of the wastewater treatment facility. However, other sites could also be considered if they are deemed to be more cost effective for this application, or if Tonini Ranch is infeasible. Specifically, if a small amount of effluent needs to be disposed beyond the capacity of an identified project, then additional spray fields could potentially be located at or adjacent to the treatment plant site. The areas shown in Figure 2 that are being considered for spray fields are all below the 200-foot



LEGEND

- Reuse/Disposal Area Boundary
- Out of Boundary

Figure 2
POTENTIAL SPRAYFIELD SITES AT TONINI RANCH
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
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topographic elevation contour line. One example of a large spray field footprint is shown in Figure 1.

3.1.2 Development and Maintenance

Water from the treatment facility would be pumped to the sprayfield site through a pressurized pipeline. Pressurized pipes can be constructed at shallower depths than gravity pipes. Based on other sprayfield disposal sites in California, the irrigation lines to spray heads would be buried less than two feet below grade. Spray heads would be detachable and approximately three feet tall. They would rotate and spray water out to a radius of approximately 15 feet and be placed at approximately 30-foot increments. A drain would be constructed at the bottom of the sprayfield slopes to collect the tailwater, and a pump would be required to reapply the water.

Because the effluent disposed at the sprayfields will likely not meet Title 22 tertiary treatment standards, the sprayfield area will have to be fenced off to prevent public contact with the water. Additionally, if secondary effluent is disposed via sprayfields, sprayheads may need to be cleaned intermittently to prevent clogging.

Depending on permit requirements, nutrient management may be required for the spray fields. Nutrient management to prevent nitrates leaching to groundwater would consist of harvesting the grass grown in the field a few times over the course of a year. This would likely involve temporarily disconnecting the spray heads in the area to be harvested, and using machinery to cut, collect and haul away the grass for landfilling, composting or animal feed. It is estimated that harvesting the grass will take 1.3 hours per acre (Iowa State University, 2001).

Grasses are one potential crop for sprayfields which can be quickly established while allowing flexibility for other crops or other beneficial reuse of the treated effluent. However, the community may decide in the future to develop other crops at a sprayfield disposal site, including crops grown for biofuel production, or a managed forest. Effluent disposal in managed forest can be achieved with a smaller area compared to sprayfields, since the trees provide increased evapotranspiration over grasses grown in a sprayfield operation. Additionally, subsurface irrigation could be used in place of sprayers, and therefore public access would not need to be limited. In an analysis of wastewater disposal in a planted redwood forest, it was estimated that such a system could use 5,000 to 7,500 gallons per day per acre, which is much more than the approximately 3,800 gallons per day per acre that is the estimated disposal capacity for sprayfields.

Using managed forest in place of sprayfields could reduce the land area for disposal by up to half or increase disposal capacity. For example, Tonini Ranch (Figure 2) could serve as a site for forestation. Slopes at the site that are too steep for spraying may be appropriate for planting some species of trees. The substantial visual and environmental impacts of planting trees would need to be evaluated as part of the environmental review process.

3.1.3 Implementation/Institutional Issues

Disposal via sprayfields do not offer any mitigation of seawater intrusion. They do, however, provide a reliable disposal alternative and could be used as an interim disposal option while reuse project alternatives with mitigation potential are developed for the future.

3.2 Leachfields

Leachfields and dry wells were designed as part of a previous project at three sites in Los Osos: at Broderson, Santa Maria Ave. and Pismo Ave. Broderson is the only potential subsurface disposal site that offers significant seawater intrusion mitigation benefit. The other sites, at Santa Maria and Pismo Avenues, are located beneath streets adjacent to homes and would be difficult to operate and maintain due to the site constraints. Therefore, only the Broderson site is under consideration for subsurface disposal in this TM.

Effluent disposal through leachfields is not dependent on weather conditions, and does not have to occur evenly throughout the year (i.e., more effluent can be disposed in the winter if less is disposed in the summer, when agricultural reuse and sprayfields can be used, as long as the instantaneous application rate does not exceed the leachfield design capacity and the annual total does not exceed the annual hydraulic loading capacity for the site.) The leachfield design capacity and annual site hydraulic loading capacity are separate site parameters.

The leachfield prototype testing, analysis, and design capacity conclusions are presented in a 2004 geotechnical report (Fugro West, 2004). A maximum application rate of 30 gallons per day per square foot (gpd/ft^2) of effective infiltration area in the leachfield trenches was recommended, based on an observed ultimate infiltration rate of 180 gpd/ft^2 during testing. Using this application rate, a minimum 10-feet spacing between trenches, the requirement for leachfield wet-dry cycles, a 100 percent capacity redundancy, and the dimensional constraints of the Broderson site, the previous project (2001) developed the Broderson leachfield design with an average application rate of closer to 7 gpd/ft^2 at full capacity.

The hydraulic loading capacity of the site is presented in a 2000 hydrogeologic study (Cleath & Associates, 2000). The estimated annual hydraulic loading capacity of the Broderson site is 896 AFY, but at that rate would require harvest wells to prevent rising water near the bay front (Cleath & Associates, 2000). To avoid the need for harvest wells, a rate of 448 AFY is recommended, which does not exceed the current level of septic returns on the west side, and therefore would not adversely impact existing shallow water conditions along the bay front.

3.2.1 Potential Sites

The potential location for the leachfield at the Broderson site is shown in Figure 3. The site would be accessed by a gravel road that extends south from the south end of Broderson

Figure 3
LEACHFIELD SITE AT BRODERSON
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

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Avenue and be surrounded by fencing to limit public access. The entire Broderson site is approximately 75 acres.

3.2.2 Development and Maintenance

In the previous design, the leachfields at Broderson occupied a rectangular area of approximately 7 acres. The leach line trenches would need to be excavated to an average depth of 6.5 feet during construction, and then re-graded. The leachfields would consist of a four-foot depth of gravel for drainage, covered by a geotextile fabric and then at least 2.5 feet of native soil backfill. The percolation piping would consist of 4-inch perforated PVC pipe laid with the perforations facing upwards, one foot below the geotextile fabric layer. If the pores in the sand beneath the leachfield became clogged over time, the leachfield would need to be excavated and rehabilitated or reconstructed. The frequency of rehabilitation depends in part of the characteristics of the effluent. A higher level of wastewater treatment would likely decrease the frequency of rehabilitation due to decreased clogging. The estimated frequency of ripping is approximately every 10 years or more.

3.2.3 Implementation/Institutional Issues

Issues related to leachfields at the Broderson site include the potential for leachfield clogging, treated effluent daylighting downslope, liquifaction potential, public perception/opposition and endangered species habitat. The past project design (2001) for Broderson had opposition from some members of the community regarding these issues.

One point of opposition was that the application rate for the leachfields is too high, and cannot be sustained due to near-surface clogging. As mentioned above, the application rate was derived from geotechnical testing which is detailed in the Fugro 2004 geotechnical report. It is recognized that the original testing was performed using groundwater, and the leachfield design was predicated on using tertiary treated water from an MBR facility.

The concern for treated effluent daylighting downslope may have risen in part due to the misconception that the lithologic bedding planes were horizontal beneath the site, whereas subsequent detailed subsurface investigation shows them to be subparallel to the slope. A flow model and separate vadose zone analysis performed for the site by Cleath & Associates showed no potential for daylighting at 800,000 gallons per day disposal. Both shallow and deep monitoring wells are part of Broderson site disposal and will allow three-dimensional tracking of the subsurface groundwater mound.

Liquifaction potential is addressed in the Fugro geotechnical report. There is a low potential for liquifaction to occur at Broderson or the offsite areas downslope as a result of effluent disposal.

Another point of opposition was that the disposal capacity was for 896 AFY that would require the harvesting of water in downstream wells to prevent problems with rising groundwater near the bay from occurring. The previous project did not fully address how to dispose of the harvest water. In this TM, disposal capacity of the Broderson site is limited to the volume of water that will not cause rising water problems near the bay and will not require harvest wells (448 AFY).

The leachfields at the Broderson site consist of 7 acres, all of which may be sensitive habitat. This issue will be explored further during environmental review.

This site has already been granted permits for construction by the California Coastal Commission, the U.S. Fish and Wildlife Service, and a waste discharge permit by the RWQCB, although these permits may need to be renewed for the County's project.

3.3 Agricultural Reuse

Agricultural reuse consists of using treated secondary or tertiary effluent to irrigate agricultural crops.

3.3.1 Potential Sites

The Rough and Fine Screening Analyses identified agricultural reuse in the Los Osos groundwater basin on land comprised of up to 230 acres on either side of Los Osos Creek and north of Los Osos Valley Rd. Potential agricultural reuse sites are shown in Figure 4.

3.3.2 Development and Maintenance

The agricultural land irrigated with recycled water can either continue to be managed with the same cropping patterns as at present, or it can be managed to maximize disposal of water by increasing the cropping intensity and/or planting crops with high evapotranspiration potential, such as grasses for forage that can be irrigated year-round. Lower cost for reuse may also be achieved by growing crops that can be irrigated with recycled water that has had a lower level of treatment. If the land is irrigated with disinfected secondary water (coliform less than 2.2 MPN/100ml), then the following can be grown (based on the California Department of Public Health Title 22, California Code of Regulations Division 4, Chapter 3, Section 60304):

- Food crops where the edible portion is produced above ground and not contacted by the recycled water,
- Vineyards where the recycled water does not come into contact with the edible portion of the crop,
- Non food-bearing trees,
- Fodder and fiber crops and pasture for animals producing milk for human consumption,

Figure 4
POTENTIAL AGRICULTURAL REUSE SITES
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

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- Seed crops not eaten by humans,
- Food crops that must undergo commercial pathogen-destroying processing before being consumed by humans, and
- Ornamental nursery stock and sod farms where access by the general public is not restricted.

The current cropping pattern of edible row crops would require tertiary filtered effluent for irrigation.

If agricultural irrigation is selected, then the treated effluent would be conveyed to the agricultural sites, where it would be discharged to a storage pond to which the farmers would hook up their irrigation systems. The pond would provide storage for approximately one day of peak water use, corresponding to up to 4-acre feet with a footprint of 1.3 acres, depending on the area of land irrigated with recycled water, and the irrigation management practices.

3.3.2.1 Salt and Nitrogen Loading

The salt concentration of the effluent, measured as total dissolved solids (TDS) is anticipated to be approximately 620 milligrams per liter (mg/L), as described in the Fine Screening Analysis. The effect of salt loading depends on the crops that are grown. The growers have registered with the County that they grow or intend to grow the following crops on the land that may be used for agricultural reuse:

- Bok Choy
- Broccoli
- Brussel Sprouts
- Cabbage
- Cauliflower
- Celery
- Cilantro
- Lettuce
- Oat
- Parsley
- Pepper
- Spinach

The salinity sensitivity of most of these crops have been studied. Of the studied crops, none are considered to be extremely salt sensitive (see Table 1). Lettuce and peppers are the

Table 1	Salinity and Crop Yield Potential[1] Los Osos Wastewater Development Project San Luis Obispo County		
	Effect of TDS (mg/l) on Yield Potential		
Crop	100% Yield	90% Yield	75% Yield
Broccoli	1045	1430	2035
Brussels Sprouts	990[2]	Not listed	Not listed
Cabbage	660	1045	1595
Cauliflower	1045	1430	2035
Celery	660	1265	2145
Lettuce	495	770	1155
Oat	1430	1760	2255
Pepper	550	825	1210
Spinach	715	1210	1925

Notes:

(1) From Grattan, 2002, electric conductivity dS/m converted to TDS with a factor of 550, except where noted.

(2) From The Essential Garden Guide http://www.essentialgardenguide.com/

crops listed here with the highest salt sensitivity and are the only crops that may be expected to be affected by the salt in the effluent. Nevertheless, the lettuce and pepper yields would still be expected to be greater than 90 percent.

Higher levels of effluent nitrogen may be permitted if the effluent is applied to crops at agronomic rates. However, nitrogen uptake rates for row crops are lower than for grass and forage crop, which were investigated as part of the sprayfield alternative in the Fine Screening Analysis. Typical nitrogen uptake rates can range up to approximately 200 lb/acre/year for non-leguminous row crops, such as those grown in Los Osos. This corresponds to a nitrogen concentration of approximately 37 mg/L at the water application rates in the area. Therefore, as stipulated in the fine screening analysis, at least partial nitrification/denitrification would be necessary for agricultural reuse if current cropping patterns continue.

If forage or grass crops were grown to maximize water and nitrogen uptake, then up to 480 lb/acre/year of nitrogen uptake could be expected from a crop such as alfalfa. With water application rates that are approximately 50 percent higher compared to row crops, this corresponds to a nitrogen concentration of approximately 59 mg/L, which is similar to the concentration that is expected in the wastewater influent. Therefore, it may be possible to irrigate under this regime with effluent that has not undergone nitrification/denitrification. However, the Regional Water Quality Control Board (Regional Board) will likely require groundwater monitoring to ensure that the recycled water application does not result in an increase in groundwater nitrogen concentrations.

3.3.3 Implementation/Institutional Issues

Agricultural reuse can be implemented either if the existing farmers agree to take the recycled water for irrigation, or if agricultural land is purchased as part of the wastewater project and tenant farmers are required to use recycled water for their crops. Purchase of agricultural land is estimated at $30,000 to $50,000 an acre, which would result in an additional $7 to 9 M cost to the project to acquire the entire 230 acres. Working with existing farmers would avoid this additional project cost. However, it is not clear at this time whether the farming community would be open to using recycled water. Developing agreements to do so could take several years. The Monterey County Water Recycling Project has delivered 12 billion gallons of recycled water each year for irrigation of high quality food crops, such as artichokes, lettuce, cauliflower, celery, and strawberries. However, this project required almost 20 years of study and extensive educational programs before it could be implemented. Because the time frame of the Los Osos wastewater project is fairly short, agricultural reuse may not be fully implementable from the outset unless the land is purchased by the project.

3.4 Urban/landscaping Reuse

Urban/landscaping reuse consists of using tertiary treated, disinfected effluent to irrigate lawns and ornamental plants.

3.4.1 Potential Sites

Urban reuse is possible at large sites such as the wastewater treatment plant site, the cemetery, Los Osos Middle School, Baywood Elementary School, Sunnyside Elementary School, Monarch Grove Elementary School, South Bay Community Center and a portion of the Sea Pines Golf Course. Figure 5 shows a detailed view of the cemetery site.

3.4.2 Development and Maintenance

The disposal capacity at the urban sites is approximately 63 AFY (Table 2) and would require approximately an additional 14,000 feet of pipe assuming that the lines for agricultural reuse and Broderson Leachfields could be used for delivering the recycled water part of the way to the urban reuse sites. Reuse at the South Bay Community Center and Sunnyside School could be achieved with very little additional piping since they are along the proposed pipeline route to Broderson, but they only have a combined capacity of 10 AFY. Since urban reuse requires tertiary treated effluent, using a shared pipeline would mean the Broderson leachfield would also have to use tertiary treated effluent.

Depending on the location of the treatment plant landscape irrigation at the cemetery and the site of the wastewater treatment plant may allow practicing urban reuse without having

Figure 5
POTENTIAL LANDSCAPE IRRIGATION SITE AT CEMETERY
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

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Table 2 Capacity and Area of Reuse/Disposal Sites[1]
Los Osos Wastewater Project Development
San Luis Obispo County

Reuse/Disposal Method and Site	Available Area (acres)	Estimated Capacity per Area AFY/Acre	Capacity (AFY)
Sprayfields (Tonini Ranch)			
With ET[2] and slow-rate percolation	190	4.8	910
ET only	80	3.0	240
Agricultural Reuse (Historical Cropping Patterns)			
West of Los Osos Creek	20	2.0	40
East of Los Osos Creek	210	2.0	420
Agricultural Reuse (Intensive Agriculture for Maximum Effluent Disposal)			
West of Los Osos Creek	20	3.0	60
East of Los Osos Creek	210	3.0	630
Urban Reuse Sites			
Cemetery	20	2.5	50
Wastewater Treatment Plant Site	8[3]	2.5	20
Los Osos Middle School	10	2.5	25
Baywood Elementary School	3	2.5	7
Sunnyside Elementary School	2	2.5	5
Monarch Grove Elementary School	2	2.5	5
South Bay Community Center	2	2.5	5
Sea Pines Golf Course (portion only)	7	2.5	16
Leachfields (Broderson Site)	7	64	448

Notes:
(1) Total 1,290 AFY to be disposed at buildout, including wet weather infiltration rates to a gravity collection system.
(2) ET = Evapotranspiration; some sites have percolation in addition to evapotranspiration.
(3) Estimated.

to construct long delivery pipelines. Irrigation demands for landscaping would occur during the same time of year as agricultural reuse, and would likewise require tertiary filtered effluent. The footprint of the irrigated acreage of the cemetery site is approximately 20 acres. The footprint of the irrigated area at the treatment plant has yet to be determined.

Urban reuse for any of the sites, with the exception of the new treatment facility, would require disconnecting the existing groundwater connections to the irrigation systems and connecting the reuse pipelines. Construction related issues include prevention of cross connections and vertical and horizontal separation of reuse pipelines from water and sewer pipelines.

Maintenance issues for urban reuse includes potential sprinkler clogging and the need for monitoring to determine compliance with all regulations such as prevention of runoff and cross connection inspections.

3.4.3 Implementation/Institutional Issues

All the school sites are existing customers of the water purveyors. Establishing an urban reuse program that includes the schools would require coordination with the purveyors. The advent of urban reuse would displace a source of income to the purveyors.

Urban reuse remains a viable alternative, but due to the limited capacity of the large sites in Los Osos, it does not constitute a significant disposal strategy for the project. Additionally, urban reuse for individual residences is estimated to be one of the most costly reuse options due to the cost of constructing a distribution system. Urban reuse can, however, be a part of any project and reuse strategies can be developed and implemented by the water purveyors in cooperation with the wastewater project.

3.5 Constructed Wetlands

Constructed wetlands are another alternative for effluent disposal. Wetlands would create habitat and a community recreational and aesthetic benefit. In the Fine Screening Analysis, wetlands were considered primarily as a storage device, although disposal through evapotranspiration would also occur in a wetland. Wetlands could potentially be sited in areas with percolation potential, however, the soil beneath the wetlands would eventually become clogged with organic material, which would impede percolation.

3.5.1 Potential Sites

If constructed wetlands are to serve as a storage device, they would likely be located near the treatment plant or at one of the reuse/disposal sites such as at the sprayfield site or at an Agricultural reuse site. A tentative site for wetlands is identified in Figure 1.

Another option for wetlands is using some land acquired as part of another reuse or disposal strategy for habitat restoration. The National Estuary Program has expressed interest in acquiring lands adjacent to Los Osos and Warden creeks to restore the historical wetlands there, albeit not using recycled water. If the wastewater project purchases the agricultural parcels containing this land, it could make the portions of the parcels near the creek available for this use.

3.5.2 Development and Maintenance

Constructed wetlands typically operate at depths of 1 to 5 feet. Areas of both vegetation and open water allow for different habitats and improved aesthetics. Open water areas would be designed at 3 to 5 feet depth to prevent plant growth, while vegetated areas would be maintained at 1 to 2 feet depth. The site would be excavated to desired depths and berms created to provide a minimum of two foot freeboard.

If wetlands are used as a storage device, wetlands sizing would depend on the storage required. If wetlands were used for evapotranspiration disposal, approximately 0.3 acres would be required for every AFY disposed.

An alternative application of wetlands would be to provide additional treatment for the effluent stream, since wetlands can be managed to enhance denitrification. A small pilot wetland could be constructed at the wastewater treatment facility to accept a portion of the flow to determine how much denitrification can be achieved. If this cell works well, then the treatment wetland could be expanded in the future to help offset the cost of denitrification though more conventional treatment. However, this option does not pertain to reuse and disposal, so it will not be further evaluated in this TM.

3.5.3 Implementation/Institutional Issues

Constructed wetlands were not fully explored as a disposal alternative in the Fine Screening Analysis because of the additional permitting constraints associated with them compared to other alternatives. The foremost of these concerns was that once a wetland is established, it needs to be maintained in perpetuity. For Los Osos, this means that the community would not retain the flexibility in the future to use the recycled water for other projects, such as urban reuse, if that was so desired.

Constructed wetlands remain a viable alternative for both storage and disposal capacity. They would have higher land requirements than other storage or disposal options, but may provide other community or environmental benefits. Further review in the environmental analysis is necessary to determined how to best incorporate constructed wetlands options into the overall project.

4.0 PIPELINES TO REUSE/DISPOSAL SITES

Each reuse/disposal site will require conveyance from the treatment plant to the site via an effluent pipeline. An effluent pump station at the plant will provide the pressure to convey the flows to the sites.

The issues associated with construction of the effluent pipeline are similar to those of the conveyance system pipeline, as discussed in the Technical Memorandum on Out-of-Town Conveyance, (Carollo Engineers, March 2008). Distribution from the effluent pump station site to the various reuse and disposal sites will likely require pipes with diameters up to 12 inches (PVC or high density polyethylene), depending on the specific routing of the pipeline. Figure 6 illustrates likely routes from the Giacomazzi area to sprayfields, leachfields and agriculture reuse sites. Most pipeline routes shown follow existing roadways (Los Osos Valley Road, Bayview Heights Drive, Turri Rd., etc) and it is assumed the pipe would be constructed in right of ways or easements in the shoulder of roadways.

The pipeline may be installed using either traditional pipe trenching methods or a trenchless method such as directional drilling or microtunneling. Directional drilling has been successfully utilized under heavily traveled roads and driveways to minimize disruption, however, this construction method typically results in higher installation costs. In most locations, open-cut trenching is a typical and economical way to install the effluent pipeline. A combination of both methods will likely be used to minimize costs and community and environmental impacts.

Distribution to reuse and disposal sites will require work on high traffic volume streets including Los Osos Valley Road and Bayview Heights Drive. Several of the routes depicted on Figure 6 will also border residential, agricultural, and sensitive habitat areas.

Locating the treatment facilities east of the Los Osos urban area will necessitate crossing Los Osos Creek with an effluent pipeline for reuse and disposal sites that are west of the creek. There are at least three options for crossing the creek: tunneling under, trenching through, and hanging the pipes on an existing bridge (where applicable). These options for creek crossing for the pipelines are discussed in the Technical Memorandum on Out-of-Town Conveyance. All three options would require permitting from federal and state resource agencies.

5.0 COMBINED REUSE AND DISPOSAL CONFIGURATIONS

None of the reuse/disposal alternatives discussed above have adequate capacity to provide disposal for all of the projected effluent, either due to total annual capacity limitations or seasonal application and uptake limitations. A combination of reuse/disposal alternatives and storage is required to meet both the startup disposal capacity of 960 AFY and the ultimate buildout disposal capacity of 1,290 AFY.

5.1 Capacity of Project Elements

In Table 2, available area at identified reuse/disposal sites are listed, and the reuse/disposal capacity at these sites in the third column is based on those areas, using the estimated capacity per unit area. Table 2 shows that while sprayfields at Tonini Ranch have

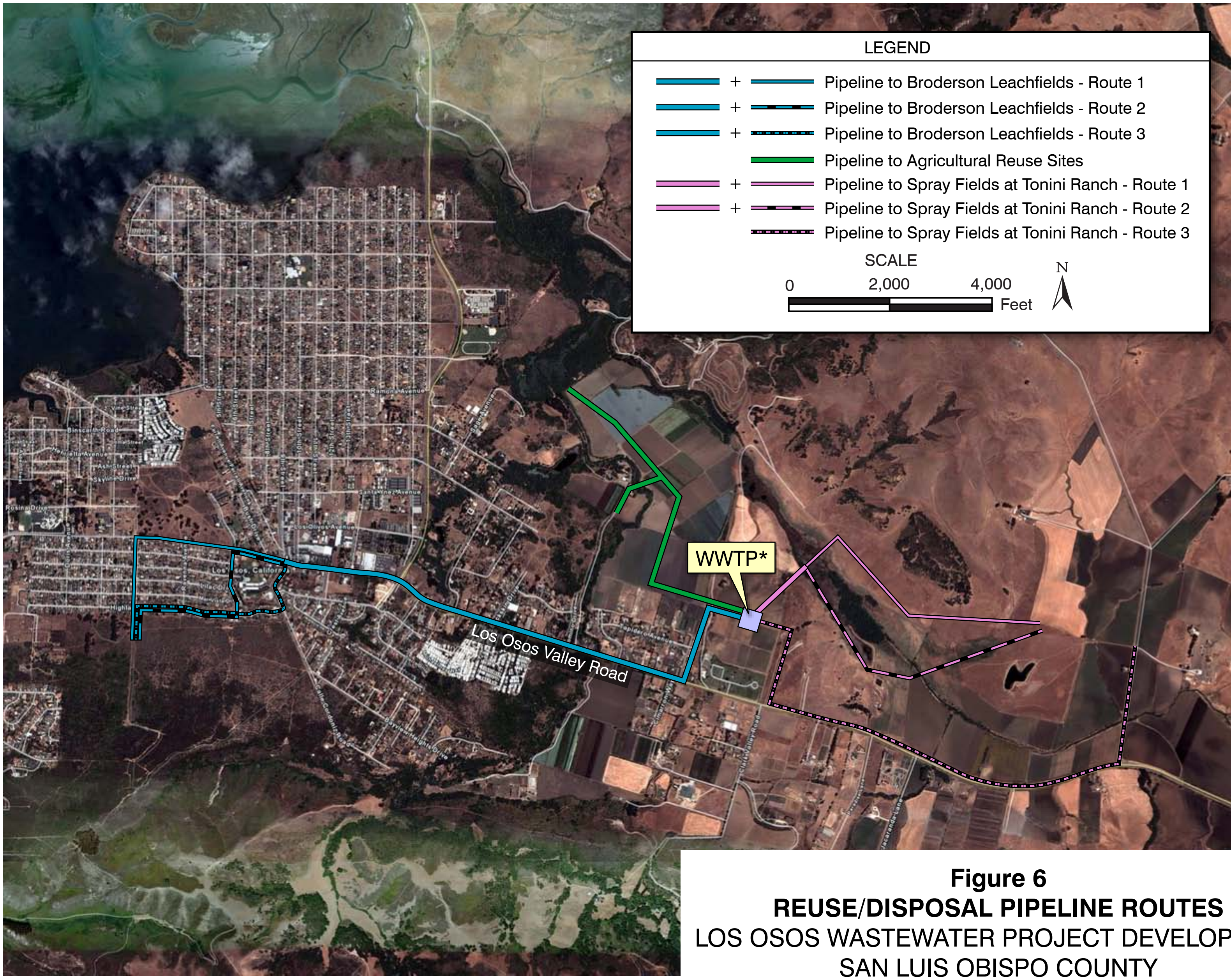

Figure 6
REUSE/DISPOSAL PIPELINE ROUTES
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

* Note that the WWTP site shown is illustrative in order to project conveyance pipe routing issues. The final WWTP site will be determined as an outcome of the environmental review process and community survey.

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the greatest total capacity, leachfields at Broderson have the greatest capacity per unit area.

5.2 Combined Projects

Based on the conclusions presented in the Fine Screening Analysis, it is anticipated that the environmental review document will be evaluating wastewater projects that have the greatest impact on seawater intrusion mitigation without requiring significant participation of the community water purveyors, i.e., Level 2 projects.

In general, Level 2 projects involve the use of leachfields at Broderson to the maximum capacity that does not necessitate harvest wells. Sprayfields and conservation are also common components. The variance of Level 2 project alternatives lies in the degree of agricultural reuse. In the Fine Screening Analysis, Level 2a (Table 3) involved practicing reuse on the entire 230 acres of cropland identified in Figure 4, while maintaining the current cropping patterns. Agricultural reuse on food crops will require use of tertiary treated water. With this quality of water, urban reuse sites could be added on to the project if determined to have a positive net cost-benefit balance. In Level 2b (Table 4), it is assumed that no agricultural reuse is developed, and the extra water was disposed via sprayfields.

Table 3 Level 2a - Agricultural Reuse Maintaining Current Cropping Patterns
Los Osos Wastewater Development Project
San Luis Obispo County

Alternative Component	Capacity (AFY)	MF(1)	SWI Mitigation (AFY)	
Spray Fields (65 acres)	312	0	0	**Total Seawater Intrusion Mitigation = 238 AFY**
Broderson	448	0.22	99	**Total Capital Cost = $12.1-12.8 M(2)**
Agricultural Reuse	460	0.1	46	
Conservation	160	0.55	88	**Total O&M = $400-440K/year**
Cemetery Reuse	50	0.1	5	
Plant Site Irrigation	20	0	0	**Treatment required = Secondary/Tertiary**
Storage (160 ac-ft)				

Notes:
(1) Mitigation Factor.
(2) Assuming agricultural land does not have to be purchased. If it does, then the cost will increase by $7 to 9M.

In this TM, we have added Level 2c (Table 5) to the list of Level 2 projects, where the full amount of agricultural land is used for reuse, but it is managed to maximize disposal by growing forage crops rather than food crops, and can therefore accept 50 percent more effluent than the agricultural land in the Level 2a project. With this much agricultural reuse, only 17 acres of sprayfields are necessary. For the Level 2c project, it would likely be more cost-effective to buy a smaller amount of land near the wastewater treatment plant site for

Table 4	**Level 2b - No Agricultural Reuse Los Osos Wastewater Development Project San Luis Obispo County**			
Alternative Component	**Capacity**	**MF(1)**	**SWI Mitigation**	**Total Seawater Intrusion Mitigation = 187 AFY**
Spray Fields (175 acres)	842	0	0	**Total Capital Cost = $13.7-15.5 M**
Broderson	448	0.22	99	**Total O&M = $440-530K/year**
Conservation	160	0.55	88	**Treatment required = Secondary**
Storage (46 ac-ft)				

Notes:
(1) Mitigation Factor.

Table 5	**Level 2c - Agricultural Reuse Managed to Maximize Disposal Los Osos Wastewater Development Project San Luis Obispo County**			
Alternative Component	**Capacity (AFY)**	**MF(1)**	**SWI Mitigation (AFY)**	**Total Seawater Intrusion Mitigation = 238 AFY**
Spray Fields (17 acres)	72	0	0	**Total Capital Cost = $17.9-18.6 M(3)**
Broderson	448	0.22	99	**Total O&M = $310-315K/year**
Agricultural Reuse	690	0.1	46(2)	**Treatment required = Secondary/Tertiary**
Conservation	160	0.55	88	
Cemetery Reuse	50	0.1	5	
Plant Site Irrigation	20	0	0	
Storage (190 ac-ft)				

Notes:
(1) Mitigation Factor.
(2) The SWI mitigation is calculated by multiplying 0.1 by the water that is offset, which is the quantity in the Level 2a project.
(3) The costs includes the purchase of agricultural land, which will likely have to be purchased in order to pursue the intensive irrigation management strategy.

the sprayfields, as opposed to purchasing the entire Tonini property. Additionally, it is assumed that the agricultural land would have to be purchased to practice intensive irrigation, so this cost is included in the capital cost in Table 5.

Because neither Broderson nor the sprayfields would require tertiary filtered effluent, the wastewater treatment plant would not have tertiary filters for the Level 2b project, and practicing landscape irrigation reuse would not be permittable. However, for the Level 2a and 2c projects which may include tertiary filtration for agricultural reuse, reuse irrigation is included for the wastewater treatment plant site, the cemetery, the Sunnyside School and the South Bay Community Center since these are all close to the pipeline routes that are planned for other alternatives.

The disposal flows that will need to be disposed at buildout (1,290 AFY) are slightly higher than those that were considered in the Fine Screening Analysis (1,190 AFY), due to changes in inflow/infiltration that were developed in the Flows and Loads TM (Carollo Engineers, March 2008). Tables 3 through 5 account for this additional flow. The capacities in Tables 3 through 5 add up to 1,450 AFY, because they include 160 AFY of conservation, which does not count as an effluent flow.

These Level 2 projects represent a range of potential options, as illustrated in Figure 7. It is likely that if agricultural reuse is implemented it would initially be on a portion of the 230 acres and be further developed over time.

With any of these project options, wetlands could be an element of the project. Also, for any of these options, managed forests could be used in the place of spray field disposal and have lower land requirements.

The capital costs for the Level 2 projects presented in this TM are lower than was estimated in the Fine Screening Analysis although the flows are slightly higher. This is because after performing a hydraulic analysis on the reuse/disposal flows it was concluded that intermediate pump stations between the treatment plant and the reuse/disposal sites would be unnecessary.

5.3 Seasonal Flows

The seasonality of the flows to the reuse/disposal sites and to storage is illustrated in Figures 8 through 10 for the three Level 2 projects identified. These flows are similar to those presented in the Fine Screening Analysis, but they account for the greater flows during the wet weather months.

Agricultural reuse is assumed to only occur during the growing season, with peak reuse flows in July. Because in Level 2c, the agricultural land is managed to maximize disposal, agricultural reuse dominated the disposal flows during the summer. No agricultural reuse is assumed between December and February. All project alternatives include leachfields at the Broderson site, and most of the winter flows can be accommodated there. However, the maximum daily capacity of the Broderson site is less than the total effluent flow. Spray fields, while operable to some extent in the winter months, have less capacity during the rainy season than the dry season, and likely cannot be operated during rainstorms. These factors necessitate the availability of winter storage. Water that is stored during the winter will be sent to spray fields or agricultural reuse during the dry season.

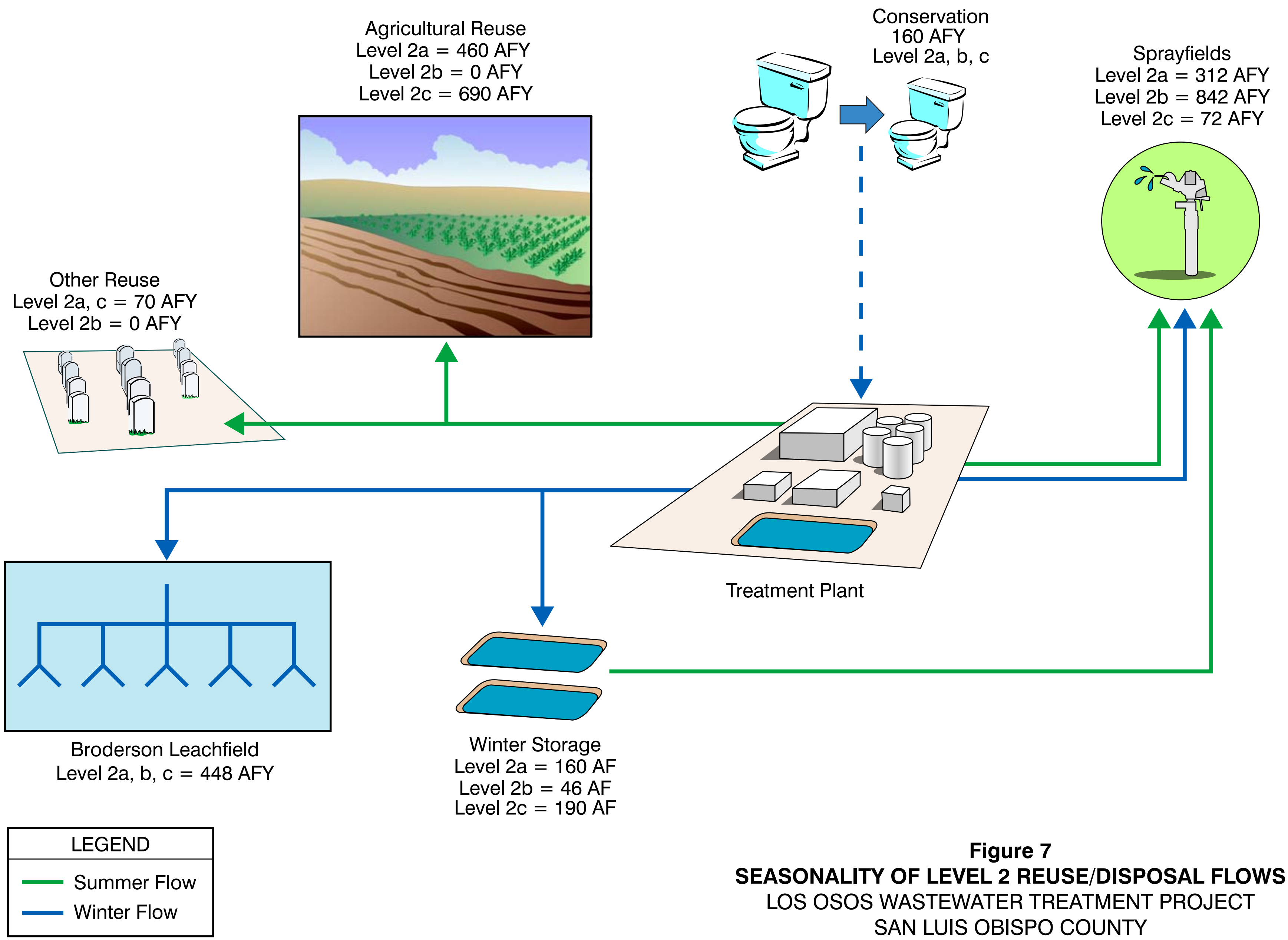

Figure 7
SEASONALITY OF LEVEL 2 REUSE/DISPOSAL FLOWS
LOS OSOS WASTEWATER TREATMENT PROJECT
SAN LUIS OBISPO COUNTY

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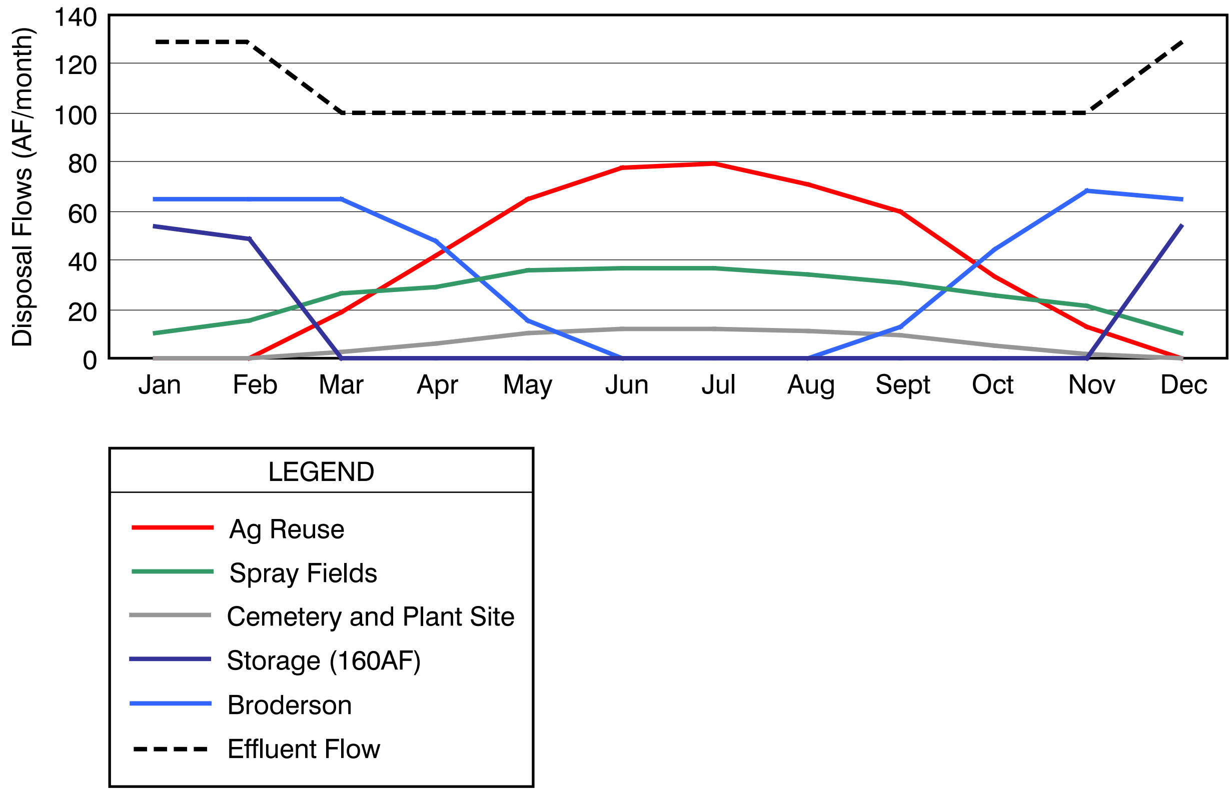

Figure 8
MONTHLY FLOWS FOR A LEVEL 2A PROJECT
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

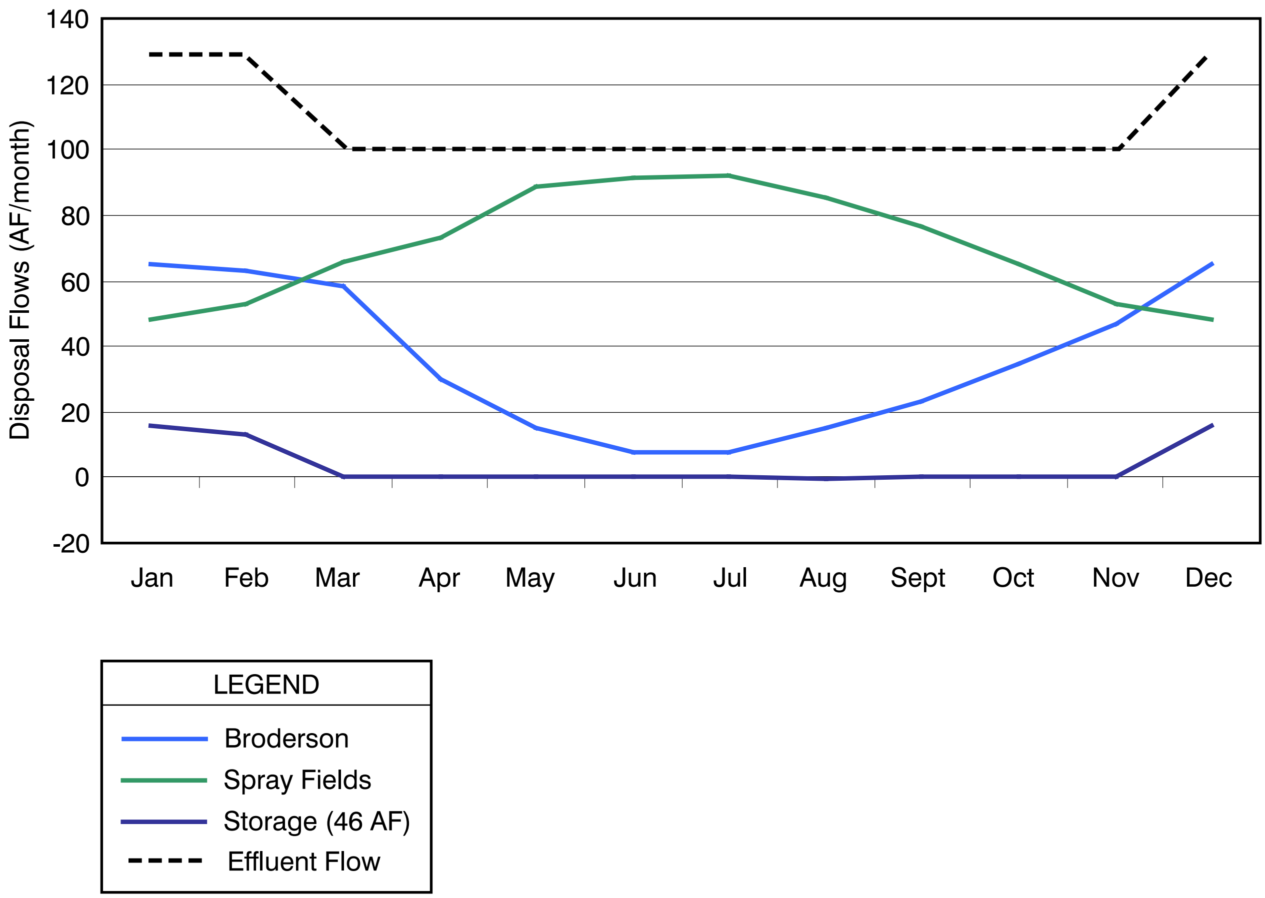

Figure 9
MONTHLY FLOWS FOR A LEVEL 2B PROJECT
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

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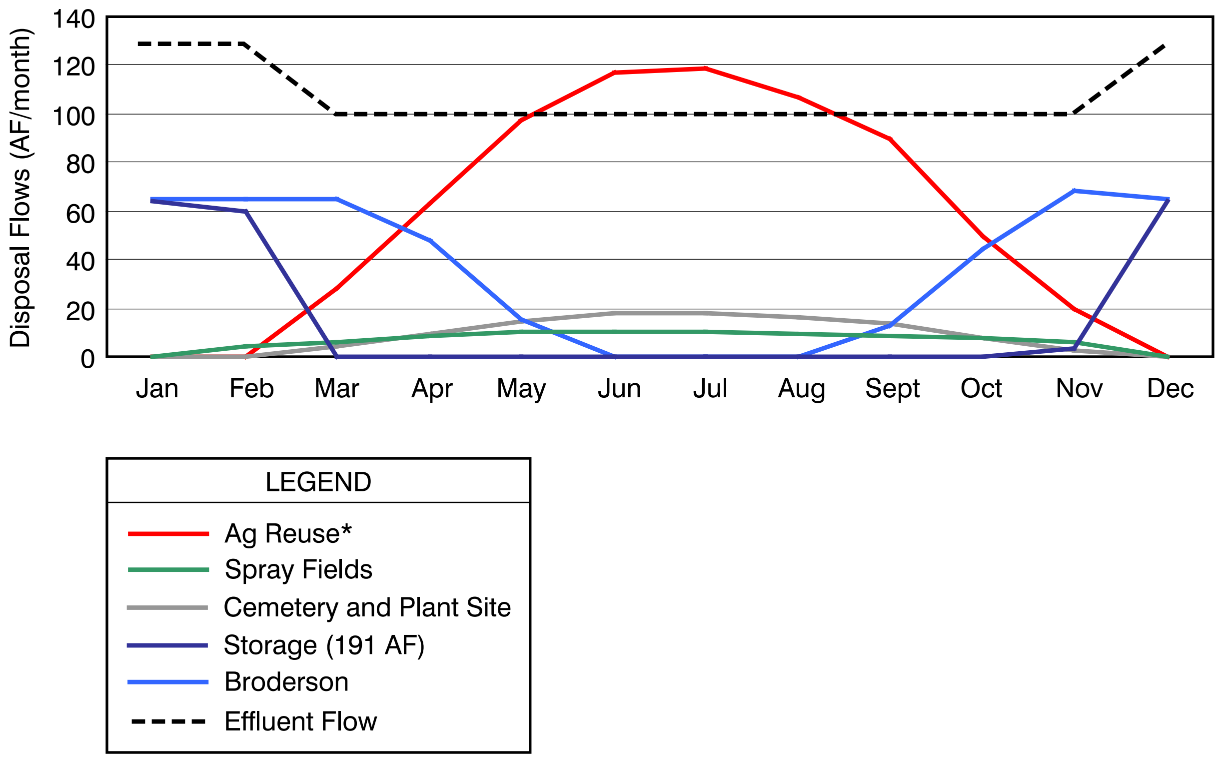

* Agricultural reuse is higher than the effluent flow in summer due to the contribution from storage.

Figure 10
MONTHLY FLOWS FOR A LEVEL 2C PROJECT
LOS OSOS WASTEWATER PROJECT DEVELOPMENT
SAN LUIS OBISPO COUNTY

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5.4 Seasonal Storage

Storage ponds would be lined to prevent percolation and the banks protected with riprap. The maximum feasible depth below grade varies depending on the site that is selected, but a depth of 15 feet should be possible in any location east of Los Osos Creek. The freeboard required for any pond would be approximately 2 feet to 4 feet to comply with seismic codes.

The footprint that would be required for storage ponds for Level 2 projects is shown in Table 6. If possible, these ponds should be located at or near the plant site to maximize flexibility of where the effluent is sent. Otherwise, the ponds would need to be sited adjacent to the sprayfield or agricultural reuse site, since these are the two major users of the stored water.

Table 6 Area Required for Storage Ponds
Los Osos Wastewater Development Project
San Luis Obispo County

Project	Storage Capacity (AF)	Area (acres)
Level 2a	160	14
Level 2b	46	6
Level 2c	190	16

After storage for several months, the effluent will need to be screened or filtered before being sent for reuse/disposal to reduce algae that could cause clogging. The ponds will be emptied as the ability to accept effluent increases at the agricultural land and sprayfields in the spring and summer. The storage ponds should be emptied in the summer and fall.

At least two parallel storage ponds whose combined volumes equal the total required storage volume should be constructed, regardless of the reuse/disposal project configuration and requisite storage volume that is selected. This redundancy ensures that at least one pond can be emptied for maintenance in the summer if the ponds are not completely drained in a year. Additionally, one pond can be used as emergency storage for raw influent.

5.4.1 Department of Safety of Dams Jurisdiction

The California Division of Safety of Dams regulates the storage of large volumes of water. However, they generally allow water stored as part of a wastewater treatment facility to be exempt from their oversight, as determined by a call to the Division of Dam Safety, and as stated in their Statutes and Regulations:

a. Notwithstanding any other provision, subject to subdivision (b), the requirements for state regulation and supervision of safety of dams, as contained in this division, shall not be applicable to waste water treatment and storage ponds constructed as a part of a waste water control facility.

b. This section applies to those ponds specified in subdivision (a) only after the governing body of the city, county, district, or other agency which operates the waste water control facility adopts a resolution which (1) finds that the ponds have been constructed and operated to standards adequate to protect life and property, and (2) provides that the city, county, district, or other agency shall supervise and regulate the design, construction, operation, enlargement, replacement, and removal of the ponds after the effective date of the resolution.

However, a wastewater project must apply for this exemption, and show that it is taking steps to satisfy subdivision b) above. If gaining an exemption is deemed undesirable due to the time and effort involved, the storage ponds could be reconfigured such that they have sufficiently low depth above grade to fall outside of the Department of Safety of Dams jurisdiction.

5.5 Water Quality Considerations

The likely effluent quality requirements for the different disposal alternatives were discussed in the Rough Screening Analysis (Table 7). It is anticipated that leachfields at Broderson will require denitrified, secondary effluent, whereas agricultural reuse would require tertiary treated effluent, but could have higher nitrogen concentrations. The exception to this would be if the agricultural lands were used for any of the restricted uses listed in Section 4.1, in which case secondary treatment would be sufficient for agricultural reuse. In the Level 2a and 2c projects, there are several months where both leachfields and agricultural reuse would occur (Figures 8 and 10). It is assumed that all alternatives will require disinfection.

Table 7 Likely Treatment Requirements for Reuse/Disposal Options
Los Osos Wastewater Development Project
San Luis Obispo County

Reuse/Disposal Alternative	Level of Treatment	Nitrification/Denitrification
Sprayfields	Secondary	Partial(2)
Leachfields	Secondary	Yes
Agricultural Reuse	Tertiary(1)	Partial(2)
Urban Reuse	Tertiary	Partial(2)

Notes:

(1) Could be secondary if agricultural land used for purposes listed in section 3.4.2.

(2) Nitrogen must be applied at agronomic rates.

6.0 SUMMARY

Sprayfields, leachfields, agricultural reuse and urban/landscaping reuse all continue to be viable reuse/disposal alternatives. Constructed wetlands may also be a viable disposal alternative for a portion of the effluent, or they can be tested as part of the treatment process to enhance denitrification. Urban reuse could also be viable for sites near pipelines that convey tertiary treated water, or can be further developed by the water purveyors.

This technical memorandum focused on disposal options for a Level 2 seawater intrusion project because that is the highest mitigation the wastewater project alone can achieve without purveyor participation. Besides the two Level 2 configurations listed in the Fine Screening Analysis, there is a third option assessed in this TM, Level 2c. The Level 2c project is similar to Level 2a, except that agricultural reuse is managed to maximize effluent disposal rather than to maintain current cropping patterns.

Regardless of which project is selected, storage will be a necessary component because there are insufficient reuse/disposal alternatives available during the winter months. Conservation is also an important component of all projects. Potential pipe routes were also identified in this TM, along with the issues that may arise during construction.

7.0 REFERENCES

Cleath & Associates, “Hydrogeologic Investigation of the Broderson Site, Phase 2 – Impacts Assessment”, prepared for the Los Osos Community Services District, 2000.

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