

Letter Report

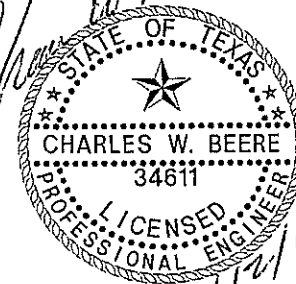
Extreme Event Drainage Study

City of La Marque



June 2002

SCL Project No. 019-0820



**SCL Engineering
11821 East Freeway, Suite 400
Houston, Texas 77029**



June 12, 2002

Ms. Carol McLemore
City Manager
City of La Marque
1111 Bayou
La Marque, Texas 77568

Re: Letter Report on Findings
Extreme Event Drainage Study
City of La Marque
SCL Project No. 019-082

Dear Ms. McLemore:

SCL Engineering, formerly Wayne Smith and Associates, Inc., is pleased to present the finding of our investigation of an analysis of extreme flooding events which occurred twice within the City of La Marque during 2001. The most severe event occurred in association with tropical storm Allison in early June 2001. Tropical storm Allison was responsible for massive flooding within the greater Houston area and to a lesser degree within the City of La Marque. Approximately eighty five (85) homes and businesses were identified by the City of La Marque as having received flood waters during tropical storm Allison. Approximately three months later another extreme storm event flooded some of the same homes and businesses a second time. Consequently, the City Council authorized SCL Engineering to begin an analysis of the reasons and potential solutions to the flooding due to the extreme weather events.

Topography is an important parameter in any analysis of extreme weather event affects upon a community. SCL Engineering determined the existing topographic contour information within the City of La Marque was limited to contours on five foot intervals. The limited topographic information would make a meaningful analysis very difficult. A topographic survey of the City's flooded areas would be extremely costly. An alternative method, utilizing methodology developed in the space program, was located where orthographic/topographic data could be provided at a reasonable cost through controlled flights over the City with imaging radar. The contour interval would be two feet and the information would be valuable to City's staff for other

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endeavors. Council authorized the acquisition of the additional topographic data on December 10, 2001.

SCOPE

The City's project scope was simply stated "determine the reason or reasons for the experienced flooding of homes and businesses and determine potential or possible solutions." Utilizing the City's defined scope the project scope was refined to include the following:

- Determine, with information provided by the City, the location of the flooded structures.
- Determine the type and extent of the current stormwater drainage facilities for the flooded structures.
- Determine the course of sheet flow or the ponding of extreme event flood waters. Extreme event flood waters are responsive to the contours of the land and not the drainage system.
- Review existing data, previous engineering studies, site observations, and the newly acquired orthographic/topographic data, to determine reasons for extreme event flood situations.
- Determine potential remedial actions or activities and provide the City with a prospective as to its ability to resolve or at least reduce the effects of extreme event flooding.
- Determine costs associated with remedial actions and activities.

INVESTIGATION

Information provided by the City indicated eighty five structures, homes and businesses were flooded by tropical storm Allison. Exhibit No. 1 presents an overview of the structures flooded. Ninety four percent of the structures flooded, all but nine structures, lie within three sub-drainage systems within the City of La Marque. The three sub-drainage systems are part of larger systems under the jurisdiction of Galveston County Drainage District No. 2. The three sub-drainage systems utilizing Galveston County Drainage District No. 2's designations are 7C

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(central businesses and homes southeast of the corner of the intersection of FM 1765 and State Highway 3, 12B (central La Marque - Lake Road and Cedar Drive areas), and 14B/14C (northeast La Marque FM 348 and State Highway 146 area). The nine structures outside these three sub-drainage areas experienced flooding due to conditions pertaining to the immediate surroundings, the extremeness of the event, and possibly blockage of the local drainage system. Most every block within the City of La Marque experienced ponding to greater or lesser degrees during the extreme events of 2001. Flooding was the result of ponded water levels exceeding the floor elevations of the structures. Most, if not all, of the flooded structures have floor elevations below the current standards for development within the City. The flooded structures are the older homes and businesses constructed prior to the adoption of the City's current developmental control ordinances.

The City of La Marque's storm sewer system is generally designed to provide capacity to handle a three to five year frequency rainfall event. Texas Department of Transportation's storm sewers also have a design capacity equal to the three year frequency event. Galveston County Drainage District No. 2 has a desired event design capacity of from the 25-year to 100-year frequency event. However, many of the older ditches have existing capacities much less than the desired event design capacity. Extreme event analysis is concerned with those periods where the existing storm sewer/ditch system has experienced a rainfall event far in excess of the design capacity of the system.

Sub-drainage Area 7C

Approximately forty four percent (37 structures) of the total flooded structures within the City of La Marque lie within the sub-drainage area 7C. Exhibit No. 2 presents an orthographic map with the limits of sub-drainage area. The vast majority of the structures lie within a section of City roughly bounded by Yaupon Street, Laurel Street, Bayou Drive, FM 1765, and State Highway 3. The area, prior to the development of the City of La Marque, was adjacent to a former creek or bayou. The remains of former creek or bayou are now generally referred to as Ditch 7C and the main Ditch 7. The old bayou or ditch generally flowed north and east from La Marque into Moses Lake. Exhibit No. 3 presents a location map of the flooded structures and existing storm sewers with the limits of the sub-drainage area.

Initial development within the City of La Marque and later within Texas City, north of FM 1765, modified, filled, and rerouted the old creek or bayou system. The old bayou system was changed into a drainage system consisting of storm sewers and an improved outfall drainage ditch. The storm sewer is currently a piped storm sewer within the right-of-way of State Highway 3. The outfall of the piped storm sewers from the above described sub-

drainage area consists of parallel 72-inch and 36-inch storm sewers beneath FM 1764 along the west side of State Highway 3. The piped storm sewers converge into a 6-foot by 6-foot box culvert at the northwest corner of FM 1764 and State Highway 3. The box culvert (previously Ditch 7C) flows north along State Highway 3 before outfall into an open ditch, Ditch 7. Ditch 7 does not have capacity to contain the 25 year event within its current top of bank.

Subsequent roadway improvements to State Highway 3, roadway improvements to FM 1765, construction of the commercial shopping centers on both sides of FM 1765 from Bayou to State Highway 3, and the railroad's raised track bed have continued the modifications to the land elevations and changes to original drainage patterns. The combination of these facilities has created a rather large bowl affect generally east of Bayou, north of Yaupon, west of the railroad bed, and south of FM 1765.

The extreme event analysis for the sub-area of Ditch 7C indicates overland flow from the area, which experienced flooding, has been interrupted by development. The sub-drainage area has become a bowl. Once the storm sewer systems, the out flow of the bowl, are flowing at capacity, excess flows must be stored within the sub-drainage area. The storage of these waters or ponding occurs with every rainfall event in excess of the design events. During events in excess of the storm sewer design, the sub-drainage area must store water until either the rainfall event ceases or the ponded waters are of sufficient depth to breach the edge of the bowl. In most cases the rainfall event has ceased prior to the flooding of structures. In 2001, the rainfall events did not cease before the flooding of structures occurred. The overflow point or lowest edge of the bowl is along the original bayou channel near the intersection of FM 1765 and State Highway 3. Development in the area - businesses, roadways, and railroad bed have combined to provide a dam to extreme rainfall event generated runoff. The depth of water necessary to breach the dam effect is estimated to be about three feet to four feet. Exhibit 4 presents an overview of the bowl effect including the approximate limits of the bowl and the location of the flooded structures within the sub-drainage area.

Sub-drainage Area 12B

Approximately twenty five percent (21 structures) of the total flooded structures within the City of La Marque lie within the sub-drainage area 12B. Exhibit No. 5 presents an orthographic map with the limits of the sub-drainage area. The vast majority of the structures lie within a section of City roughly bounded by Cedar Drive, Lilac Street, Boss Street, and 300 feet west of Lake Road. Sub-drainage area 12B is served by a pipe storm sewer system beginning at the end of an open concrete lined drainage ditch 12A on the

north side of Lenz Street. The open concrete lined Ditch 12A is maintained by Galveston County Drainage District No. 2. Ditch 12A can contain a 25-year frequency rainfall event within the current top of bank. The piped storm sewer system extends north along an old creek or bayou alignment to Cedar Drive and northward to Boss Street. The old bayou or ditch generally flowed south and east into Highland Bayou. Sub lateral pipes of the main storm sewer extend along Oaklawn Drive to Bayou Road, along Magnolia Drive from Lake Road to Bayou Road, along Cedar Drive from Lake Road to Bayou Road, along Lake Road from Houston Drive North to Lake Park Drive, along Jackson Street from Lake Road to Linden Street, and along back lot lines east and west of Roosevelt Street. Exhibit 4 presents an overview of the closed pipe system. The pipe system ranges in size from twin 8' by 4' box culverts to 15" concrete pipe. Exhibit No. 6 presents a location map of the flooded structures and existing storm sewers with the limits of the sub-drainage area. The pipe system south of Cedar is generally maintained by Galveston County Drainage District No. 2. The City of La Marque maintains the pipe system generally along and north of Cedar Drive.

A report, "Ditch 12 Watershed Analysis," prepared for Galveston County Drainage District No. 2 in September of 1988 detailed the inadequacy of the pipe system to handle the flow of the three year frequency event with a twenty five year tail water or backwater within Ditch 12A. Generally, the inadequacies of the piped system are manifested at locations north of Cedar Drive. The report defined a number of improvements to the drainage system to provide the pipe system with the ability to handle the design three year event with a twenty five year tail water or backwater within Ditch 12A. The defined improvements are not designed to handle the extreme event rainfall experienced by the City of La Marque in 2001. However, the defined improvements to the pipe system would provide a better conveyance of outflows, allow deepening of many of the existing roadside ditches, and thereby provide a greater ability to convey and/or pond flood waters short of flooding structures.

The sub-drainage area 12B is a series of bowls. Once the storm sewer system, the out flow of each of the bowls, is flowing at capacity, excess flows must be stored within each succeeding bowl area. The storage of these waters or ponding occurs with every rainfall event in excess of the design events. During events in excess of the storm sewer design, each bowl area must store water until either the rainfall event ceases or the ponded waters are of sufficient depth to breach the edge of the bowl. In most cases the rainfall event has ceased prior to the flooding of structures. In 2001 the rainfall events did not cease before the flooding of structures occurred. Exhibit 7 presents an overview of the bowl effects including the approximate limits of each bowl and the location of the flooded structures within each bowl area.

Sub-drainage Areas 14B/14C

Approximately twenty one percent (18 structures) of the total flooded structures within the City of La Marque lie within the sub-drainage areas 14B and 14C. Exhibit No. 8 presents an orthographic map with the limits of sub-drainage area. The vast majority of the structures lie within a section of the City roughly bounded by Winding Way, Texas Avenue (FM 348), Ross Avenue, and Robbie Street. Ditch 14B begins on the north side of Texas Avenue (FM 348) about 150 feet west of Ross Avenue. Ditch 14B collects the out flow from a storm sewer system constructed with Texas Avenue (from about 100 feet west of Winding Way to Holman Avenue) by the Texas Department of Transportation. Ditch 14C crosses Texas Avenue, just east of Circle Drive, and the upstream end extends as far south as Robbie Street. Sub-drainage areas 14B and 14C, prior to the development of the City of La Marque, were adjacent to former creeks or bayous, the remains of which north of FM 1764 are now generally referred to as Ditch 14. The old bayou or ditch generally flowed east and north into Moses Lake. None of the existing ditches, Ditch 14B, 14C, or 14 has the capacity to contain the 25-year frequency event within the current top of bank. Exhibit No. 9 presents a location map of the flooded structures and existing storm sewers with the limits of the sub-drainage area.

A report, "Ditch 14 Watershed Analysis", prepared for Galveston County Drainage District No. 2 in March of 1986 detailed the inadequacy of Ditch 14B and Ditch 14C along with the main Ditch 14. The report investigated out flows of 25-year and 100-year rainfall events and found all three of the ditches to have inadequate channel capacity and to contain restrictive road crossings. Both rainfall events yielded water surface elevations several feet above the top of the bank of the existing channel. A few of the channel and restrictive crossing improvements has been undertaken since the report but most of the channel and crossings have not been improved. Ditch 14B has undergone channel improvements north of Texas Avenue. Ditch 14C has undergone channel improvements south of Texas Avenue along with a crossing improvement at Texas Avenue.

Ditch 14B, the storm sewer system within Texas Avenue, and the drainage ditches/roadway culverts adjacent to the west side of Ross Avenue are the primary drainage systems for the fourteen homes or businesses flooded within Sub-drainage Area 14B. Ditch 14C, a drainage ditch on the east side of Ross Avenue, and the Ross Avenue cross culvert near Chip Street are the primary drainage system for the three homes flooded on Chip Street. The Texas Avenue storm sewer system and the drainage ditch/roadway culvert systems are designed for three year frequency rainfall events.

The extreme event analysis for the sub-area of Ditch 14B indicates overland flow from the area which experienced flooding has been interrupted by development. The sub-drainage area has become a series of bowls. Once the storm sewer systems, the out flow of the bowl, are flowing at capacity, excess flows must be stored within the bowl area. The storage of these waters or ponding occurs with every rainfall event in excess of the design events. During events in excess of the storm sewer design, the sub-drainage area must store water until either the rainfall event ceases or the ponded waters are of sufficient depth to breach the edge of the bowl. In most cases the rainfall event has ceased prior to the flooding of structures. In 2001 the rainfall events did not cease before the flooding of structures occurred. The overflow point or lowest edge of the bowl series is along the original bayou channel about three to four hundred feet west of Ross Avenue. Development in the area - businesses and roadways have combined to provide a dam to extreme rainfall event generated runoff. The depth of water necessary to breach the dam effect varies from street to street with the lowest area being along Wisteria. Exhibit 10 presents an overview of the bowl effects including the approximate limits of each bowl and the location of the flooded structures within the bowl areas.

POTENTIAL REMEDIAL ACTIONS

The following is a brief summary of the findings, limitations, and of potential remedial actions along with an engineering opinion/assessment of the actions ability to effectively reduce or eliminate the flooding of structures by extreme rainfall events.

Sub-drainage Area 7C

The thirty seven structures flooded within the sub-drainage area defined as 7C have no effective way of escaping flooding from a repeat event or events such as occurred in 2001. The structures lie within the confines of a topographic bowl generated by development of roadways FM 1765 and State Highway 3, commercial development along FM 1765 west of State Highway 3, and the railroad bed along the east side of State Highway 3. Lowering of the bowl lip would require the roadway, railroad bed, and commercial establishments to undergo severe alterations. The necessary alterations are not practical nor very cost effective. Installing additional pipes beneath the intersection of FM 1765 and State Highway 3 does not remedy the extreme event situation without downstream culvert and outfall ditch improvement. The drainage system is full downstream and the addition of more or larger outflow pipes into a full system will not allow much if any additional outflow. The most practical alternative would be to lower the backwater (tailwater) affects downstream on Ditch 7. No engineering investigation has occurred on Ditch 7 by

the Galveston County Drainage District No. 2 or the City of Texas City to determine the ability, practicality, or costs associated with the lowering of the backwater. However, a lower backwater would lessen the upstream storage (ponding-flooding). Lowering the backwater is a necessity before any other improvement can occur. Drainage improvements must be constructed from downstream to upstream. The outfall ditch, Ditch 7, must be able to contain at a minimum the 25-year event within the top of bank.

Sub-drainage Area 12B

The twenty one structures flooded within the sub-drainage area defined as Ditch 12B have several possible methods or combinations of methods for reducing potential flooding from a repeat event or events such as occurred in 2001. The structures lie within the confines of a series of topographic bowls generated by the development of roadways during the initial land development years ago. A report, "Ditch 12 Watershed Analysis", prepared for Galveston County Drainage District No. 2 in September of 1988 detailed a number of improvements to the pipe storm sewer system to handle the flow of the three year frequency event with a twenty five year tail water or backwater within Ditch 12A. Exhibit 11 presents a pictorial summary of the proposed improvements. While these improvements alone may not reduce or eliminate flooding, the proposed improvements will provide better drainage during normal rainfall events. Additionally, the improvements would better convey the initial runoff from extreme event rainfalls thereby reducing the necessary storage needed later in the event. A reduction in storage is a reduction in water depth and potentially a reduction in the flooding of structures. The 1988 cost estimate for the storm sewer improvements was \$1,242,900.00 which included 25% for engineering and project contingencies. The adjusted cost would be \$1,801,420.00 in May 2002 dollars. The division of costs between the City of La Marque and Galveston County Drainage District No. 2 was not defined by the 1988 report. The availability of funds for either entity is unknown. However, the implementation of the proposed storm sewer improvements should be considered, at least the initial phase of a potential two prong attack.

The second prong, if warranted by future continued flooding, would be to lower the lip of the bowls and thereby reestablish the original concept of sheet flow. Lowering of the lip of the series of bowls would reduce water levels by reestablishing sheet flow interrupted by roadway placement during the initial development long ago. Lowering the lip would require the lowering of the street or roadway in the area of the old bayou channel. This approach is generally reserved for secondary streets, not major thoroughfares, and is more applicable to asphalt roadway construction rather than concrete roadway construction. Lowering of the roadway would reduce ponding and subsequent structure flooding but on the negative side reduce mobility during extreme rainfall events, likely increase roadway

maintenance costs, and might affect downstream conditions if carried to excess. The roadways would require at least a fifty foot dipped section be lowered to about six inches below the lowest flooded structure floor elevation. Caution must be exercised about lowering roadway sections. Lowering too much or too many roadway sections might not only become a safety hazzard to traffic if made too steep but might increase downstream flooding. Trading upstream flooding for downstream flooding is not a desirable result nor is it a viable solution.

Sub-drainage Areas 14B/14C

The eighteen structures flooded within the sub-drainage area defined as Ditch 14B/14C have several possible methods or combinations of methods for reducing potential flooding from a repeat event or events such as occurred in 2001. The structures lie within the confines of a series of topographic bowls generated by the development of roadways during the initial land development years ago. A report, "Ditch 14 Watershed Analysis", prepared for Galveston County Drainage District No. 2 in March of 1986 detailed a number of improvements to the downstream ditch system to lower the tail water or backwater of twenty five year event to remain within the top of bank. The improvements would lower the 25-year and 100-year water surfaces of Ditch 14B at Texas Avenue (FM 348) about two feet and of Ditch 14C at Texas Avenue about one foot. A reduction in the backwater should increase the conveyance of the existing system during an extreme event rainfall thereby reducing the necessary storage needed later in the event. A reduction in the storage requirement is a reduction in the water levels and a reduction in the flooding extent. The 1986 cost estimate for improvements to downstream Ditch 14 and Ditches 14B/14C was \$2,473,000.00 which included 25% for engineering and project contingencies. The adjusted cost would be \$3,767,060.00 in May 2002 dollars. Additionally, a new cross culvert (30") should be installed across Ross Street at the intersection with Chip Street. The current cross culvert configuration north of Chip Street effectively provides a hydraulic blockage to the drainage from the Chip Street area. The estimated cost to install a new 30-inch culvert is about \$2,500.00. The cost would be substantially less if provided by City forces.

Shady Lane

Previous to the authorization for this report, SCL Engineering investigated a location of repeated flooding. The location was on Shady Lane just northeast of the intersection with Oak. The storm sewer along the north side of Shady Lane crosses an existing City waterline at Oak. The storm sewer and water line are in conflict. The City should either construct a junction box at the point of conflict or relocate (raise or lower) the water line.

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The storm sewer outfall into the ditch along Oak should be turned to enter the ditch at an angle (preferably 30 degrees) downstream rather than at the current right angle. The estimated cost for the improvements would be about \$5,000.00. The cost would be substantially less if provided by City forces.

RECOMMENDATION

The elimination of flooding from extreme events is difficult and under most cases financially impractical. Extreme event frequency rainfalls and resultant flood issues are rare occurrences and beyond the practical economics of most governmental agencies. Flood control, in the most practical sense, must begin with the downstream facilities before upstream facilities can be improved and have any significant impact on flooding issues. In the case of the City of La Marque, the downstream facilities are Ditches 7, 12, and 14. These ditches should as a minimum standard be able to handle at least the 25-year frequency rainfall event and subsequent runoff. The ability to handle even greater events would be beneficial. Only Ditch 12 currently has the capacity to handle at least the 25-year frequency rainfall event within the top of bank.

Consequently, SCL Engineering recommends Ditches 7 and 14 along with their subsystem Ditches 7C, 14B, and 14C be improved to handle at a minimum the 25-year frequency rainfall event runoff. Ditch 7 has not been studied and the net result of increasing downstream capacity on upstream water surfaces is unknown. Additionally the costs associated with the necessary improvements is unknown. A study of Ditch 7 should be undertaken to determine the necessary improvements, costs, and downstream effect of the necessary improvements. A previous study of Ditch 14B indicates improvements to Ditches 14 and 14B would result in a water surface reduction at FM 348 (Texas) of about 2.5 feet for the 25-year event. The same study indicated a Ditch 14C water surface reduction at FM 348 (Texas) of about 1.1 feet for the 25-year event. A reduction of 2.5 and 1.1 feet respectively maybe sufficient to substantially reduce upstream water surface elevations due to extreme events. Even if the downstream improvements do not totally eliminate upstream flooding, the downstream improvements must be accomplished before any other task can be undertaken upstream and for the upstream task to have any appreciable effect on water surface elevations. The City and Drainage District No. 2 should pursue the changes to the downstream sections of Ditches 14, 14B, and 14C. The estimated cost for improvements to Ditches 14, 14B, and 14C is \$3,767,060.00 in May 2002 dollars. The City should install a cross culvert (30") across Ross Street at the intersection with Chip Street at an estimated cost of \$2,500.00. Ditch 12 currently has capacity to handle at least the 25-year event within the banks of the improved concrete open ditch section downstream. A previous study identified changes to the upstream drainage subsystem 12B. SCL Engineering recommends the City and Drainage District No. 2 pursue the changes to the upstream storm sewer system for drainage subsystem 12B. The upstream improvements will not only provide much better three year frequency event drainage but

will help reduce the amount of stored water during events greater than the design. A reduction in stored water maybe sufficient to reduce extreme event flooding of structures. The estimated cost for improvements to the drainage subsystem 12B is \$1,801,420.00 in May 2002 dollars. The conflict of storm sewer and waterline at the intersection of Shady and Oak should be resolved and the storm sewer outfall adjusted to an angle downstream at an estimated cost of \$5,000.00.

Additionally, SCL Engineering recommends the City:

- Develop a comprehensive ditch culvert, storm sewer maintenance program. The City of La Marque should adopt a program to clean all ditches, driveway culverts, and storm sewers periodically on a scheduled maintenance routine. The program would envision cleaning a particular system once every 5 to 10 years (frequency would depend upon City's financial ability). Additional cleaning might become necessary due to aggressive siltation in some locations.
- Develop a citizen awareness and participation program backed by City partnership. The citizen awareness/participation program should enlist citizens to notify the City of plugged or blocked systems. Upon notification, the City must take action to remove the blockage and work with its citizens to prevent flooding. Citizens should be educated not to dump or place debris, grass clippings, etc. into any drainage system at any time. Even the careless leaving of toys and/or sporting goods (balls, bats, gloves, etc.) especially in or adjacent to the open roadside ditches located in front of most of the residences may become an obstacle to the drainage if swept into the system. The accumulation of these materials may contribute to the flooding of structures. Drainage and flood abatement must be made a joint effort of the City's staff and the City's citizens.
- Make a minor addition to the City's subdivision ordinance. The City should undertake a minor change to the subdivision ordinance to require developers or land owners, developing more than 5 acres, to provide the City with an extreme event analysis at the time of plan submittal. The purpose would be to prevent the construction of a structure in the path of a future extreme event's surface runoff.
- Encourage citizens to obtain flood insurance and develop family disaster plan. The City should encourage all citizens to obtain flood insurance regardless of the structures proximity to a delineated flood plain. None of the structures flooded within this report are within a delineated flood plain. The City should also encourage citizens to develop a family disaster plan. The plan should assist family members in reassembling in a safe location should a flood or another disaster affect

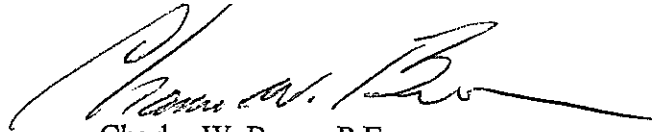
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their current residence.

SCL Engineering hopes the above information is sufficient for your needs, SCL Engineering will be happy to discuss this report and its implications at your convenience. Should you have any questions, please advise.

Very truly yours,

SCL ENGINEERING



Charles W. Beere, P.E.
Vice President

