FINAL MODEL PLAN
FOR
SEWER SYSTEM EVALUATION AND REHABILITATION PROGRAM
SEWERAGE AND WATER BOARD OF NEW ORLEANS

July 11, 1997

INTRODUCTION

Since the submission of the original Model Plan for New Orleans in December 1996, Montgomery Watson has carried out further investigations to characterize the sewerage system. This effort has enabled the development of this Final Model Plan which includes a modeling methodology specific to the needs of the New Orleans sewerage system. The Final Model Plan also addresses the points raised by the EPA in their letter of February 6, 1997 in response to the original Model Plan. It also confirms points raised in the conference call of March 26, 1997 involving representatives of EPA, the Sewerage and Water Board (S&WB) and Montgomery Watson.

A copy of this Final Model Plan is submitted to Region VI of the Environmental Protection Agency pursuant to settlement discussions in Civil Action No. 93-3212, Section "T". The plan itself has been prepared by the Board as part of its overall plan to study and repair the New Orleans sewage collection system. The primary objective of this Model Plan is to review and evaluate sewer system models and to define the basic applications and technical requirements for hydraulic modeling which will be performed for the Sewerage and Water Board (S&WB) wastewater collection system. Specifically, in conjunction with negotiation of the draft consent decree to resolve the aforementioned action, this Model Plan shall:

a. list the manner in which the collection system will be modeled;

b. describe the components of the collection system to be modeled;

c. identify the placement of flow monitoring equipment;

d. specify the procedures to be used to configure, calibrate and verify the Model, the type of data that will be collected, the type of model that will be developed, and the procedures to be used to ensure that the data can serve as a valuable predictive tool;

e. specify the software or software packages to be used;

f. describe the manner in which the Model will be used in the collection system evaluation studies to analyze the existing capacity of the system and the sources and fates of extraneous flows, and the manner in which the Model will be used to develop the Base Facilities Action Plan;

g. describe the resources to be committed to the installation of the hardware, software, and data collection equipment, as well as the resources for data collection and evaluation and Model development;

h. describe who will be developing the Model; and include a schedule for the installation of the monitoring equipment, completion of preliminary data gathering and completion of Model development.

In addition, this model plan accomplishes the following:

i. It attempts to ensure that all modeling and data collection activities are done in a way which is compatible with the CASS WORKS data base system operated by the City of New Orleans.

j. It introduces the concept of using Real Time Control (RTC) to maximize the capacity of the existing system.

CHOICE OF MODELING SOFTWARE

Based on an initial overview of the New Orleans sewerage system and on Montgomery Watson's experience on other major projects of this type, it has been determined that the modeling software must fulfill the following requirements:

(i) It must be dynamic to simulate the manifolded force mains and switching on and off of pump stations

(ii) It must be able to represent the attenuation effects of in-system storage and the drain down of the system after rainfall events

(iii) It must be capable of simulating gravity flow in some pipes and pressure flow in others during the same simulation.

(iv) It must have the ability to simulate Real Time Control so that control rules can be developed to optimize the performance of the system.

(v) It should ideally be able to apply diurnal variations to base sanitary flows and automatically switch between weekday and weekend profiles.

(vi) It should allow for the input of dry weather infiltration as a separate entity.

The chosen hydraulic modeling software to meet these requirements is HydroWorks. HydroWorks has the additional benefit in that it uses a variable time step to solve the differential equations used in the hydraulic calculations. This means that initially the user can specify a large time step for these calculations. If at any stage the program detects that the chosen time step has the possibility of causing instability in the solution, HydroWorks will automatically reduce the time step to compensate. When the solution has stabilized, it will revert back to the originally specified time step. Running at large time steps reduces the time taken to carry out simulations of rainfall events. This is especially important if continuous simulation proves necessary.

An add-on to HydroWorks is available which provides the capability to route pollutants, both dissolved and attached to solids, through a sewer system along with water. This model simulates the mixing of dissolved pollutants and the transport, deposition, and resuspension of solids. This feature can be used to identify potential solids deposition problem areas in the sewer system that should be targeted in a proactive flushing program. It is also possible to predict the water quality benefits achieved by storage/treatment facilities, and even estimate the magnitude of the "first flush" phenomenon (i.e., higher concentration of solids in the early part of the RDI/I hydrograph) at any given location. The ability to quantify water quality benefits could be instrumental in obtaining permits to operate such facilities and in justifying occasional discharges from them to receiving waters.

EXTENT OF MODEL

Although the consent decree only requires the modeling of the East Bank sewerage system, modeling of the West Bank sewerage system will also be carried out in order to ensure that the West Bank system continues to meet the same level of performance as is achieved by the upgraded East Bank System. There will therefore be at least two separate models as the East and West Bank sewerage systems drain to two separate wastewater treatment plants and form completely independent systems. It might be argued that the East bank sewerage system could be split into independent models as there are at least two separate force main systems draining to the East Bank plant. However it would seem prudent to keep them as one model so that solutions involving transfer of flows from one system to another can be considered.

The number of modeled pipes in this East Bank model will be kept to a limit which will allow the inclusion of more detailed models of individual basins when Sewer System Evaluation Studies (SSES) studies are carried out. The Lakeview basin has already been the subject of such a study. As part of this study separate detailed models of the gravity sewer systems draining to each of the seven pumping stations in the basin were constructed by the consultant, RJN, using the XPSWWM software. These models have been obtained by Montgomery Watson and have been converted to the HydroWorks software. It is planned to combine these models into one, connecting them with the manifolded force main, to determine if any changes to the proposed rehabilitation measures are required.

THE MODELING PROCESS

The modeling methodology outlined in this Final Model Plan was presented to and discussed with the S&WB at a Modeling Workshop held on April 11, 1997. The workshop had as its theme "The Making of a Model" and the presentation evolved around the key slide defining the process which is reproduced as Figure 1.

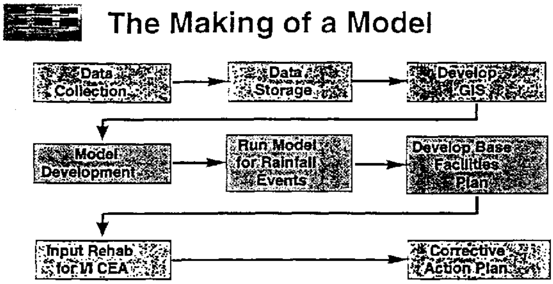

FIGURE 1

DATA COLLECTION

This is probably the most time consuming of all the tasks involved in the making of a model. The data required covers the physical data about the system which forms the basis of the model data file, flow monitoring data used for the calibration and verification of the model, long term rainfall data used for model simulations when assessing current performance and future improvements, and the history of past and present problems in determining which areas are worthy of more detailed investigation. Data is also required about the wastewater treatment plants as they generally have an interaction with the sewerage system. Possible impacts of proposed changes to the sewerage system on the wastewater treatment plants will be fully evaluated.

Physical Data

Basic data on manholes and sewer lengths for the New Orleans sewerage system is held by the S&WB in a CASS WORKS database. Inspection of this database indicates that while basic information on connectivity, pipe size and material is generally present, there is only limited information on manhole level and sewer depth. An extensive topographic survey is therefore required to obtain this information. This information is an essential requirement of the model if it is to accurately predict the performance of the systems. The survey will also confirm the co-ordinates of the manholes. It will also include manholes for which data is available to ensure that everything is related to a common datum.

Inspection and testing of all the sewerage pumping stations operated by the S&WB has recently been completed by Montgomery Watson. This has provided the details of wet well sizes, pump curves and control levels required by the model. These details are again an essential input into the model. The control levels are presently related to temporary bench marks at each pumping station set by Montgomery Watson during the Pumping Station and Force Main survey. These require leveling to a datum common to the rest of the sewer system. This leveling will take place during the topographic survey of the manholes.

For ease of model construction it is necessary to have the plan view of the sewer system displayed on a computer. This will be accomplished by the digitizing of the S&WB's existing paper records of the system. The digital plan, when overlaid on the city's digital two line street map, will also facilitate the production of layout plans and drawings.

Sub-basin data

A sub-basin, in modeling terms, is the area which contributes base sanitary flow, ground water infiltration and rainfall derived inflow and infiltration to a specific manhole in the model. This does not necessarily imply that every modeled manhole will have an associated sub-basin, but the entire area of New Orleans parish which contributes flow will be included in the total area covered by sub-basins.

It is necessary to be able to determine the base inflows to the sanitary sewer system and the hydrological properties of each defined sub-basin. To this end details of land use, zoning , resident population and the location of industrial and commercial properties will be collected. The planning horizon will be reviewed so that estimates of future changes in base sanitary flows can be allowed for when developing solutions to problems. Zoning maps have been obtained. Land use maps were drawn up under the supervision of Montgomery Watson in the preparation of the Stormwater NPDES permit in 1991. These will be updated. Census tract information will be obtained as will NPDES data for industries. Major commercial centers will be identified and their locations recorded.

Details of service requests are also contained in the CASS WORKS database. These will be reviewed to ensure that sufficient detail is included in the models to enable detailed analysis of areas with recurrent problems.

Flow monitoring

A temporary flow monitoring survey was carried out over an eight week period from February 27, 1997 to April 23, 1997. The survey included 75 flow monitors, 20 rain gauges and 30 high water level monitors. Details of the monitor locations are given in Appendix 1. The data collected will be used to calibrate and verify the model under both dry weather and storm conditions.

Thirty of the temporary sites are proposed to become permanent flow monitors. Details of the currently preferred locations for these monitors are given in Appendix 2. These sites are currently under review in light of the data obtained from the temporary flow monitoring exercise in order to confirm their usefulness. Other possible locations for permanent monitors which were not covered by the temporary flow monitoring, i.e. in force mains, are being investigated. The long term data obtained from these permanent monitors will show seasonal changes in base infiltration levels and in population generated base sanitary flows. The data should help determine if there is a relationship between rainfall derived inflow/infiltration and antecedent conditions.

Rainfall Data

Long term rainfall data will be collected and analyzed to determine critical rainfall periods to be used with the model when assessing the current performance and developing solutions to problem areas.

There is a USGS gauge at Slidell and a long term gauge at New Orleans international airport. In addition, the S&WB maintain their own network of gauges, some of which have several years of record. Use may be made of the data from the NEXRAD weather radar, located at Slidell, for establishing patterns of the spatial variation of rainfall across the catchment area.

A review of preliminary data collected by the temporary flow monitoring program has shown that the sewer system can take two to three days to return to "normal" base dry weather flow levels after a significant rainfall event. This fact will influence the definition of the inter-event dry weather period for identifying independent rainfall events. It may also indicate that continuous simulation using significant groupings of historic rainfall events would be more appropriate to the analysis of the New Orleans sewer system rather that the return period design storm approach. The choice of methodology for design rainfalls will be determined by the nature of solutions considered.

DATA STORAGE AND GIS

All data collected as part of the modeling study will be entered into a computer database where it will be reviewed and downloaded into the formats necessary for modeling. For quality assurance reasons it is intended that data should be entered and updated only through this database and not by the editing of individual model files. The output of model simulations will also be transferred back to the database for storage and review. A Geographical Information System (GIS) will be used to facilitate the display, interrogation and downloading of data.

It is recognized that any systems developed by Montgomery Watson during the course of their studies should be fully compatible with the S&WB's computer systems. As such the CASS WORKS database will be the final repository for all physical data on the sewer system and MW will develop systems for downloading data from this database and updating it with new survey information.

It is believed that the city is moving to the use of the Arcview GIS software and Montgomery Watson will therefore use this software for their GIS applications.

MODEL DEVELOPMENT

Once all necessary data has been collected the process of model development can begin. It will start by identifying all sewers of 12" diameter and greater for inclusion in the model. Although the full length of these sewers will be included, some intermediate manholes, across which the sewer line maintains a constant grade and size, may be omitted. This is in order to maintain the number of modeled nodes at an acceptable level. All force mains will be included.

The digital overlay of the sewer system plan on the two line street map will be used to delineate sub-basins draining to the modeled nodes. The sub-basin outline is determined by the network of 6, 8 and 10 inch sewers feeding to the node. In addition the CASS WORKS database will be queried to extract all work activities associated with the sanitary sewer system. These work activities will be displayed geographically by means of the GIS system and any concentrations of activities due to surcharge or overflow in sewers smaller than 12" will be identified. The modeled sewers will, if appropriate, be extended back into these areas by the inclusion of the smaller sewers. The sub-basin delineations will be amended to reflect these additional sewers. Also if any sub-basin areas become too large, i.e. significantly greater than 100 acres, then smaller sewers will be included to allow the sub-basin to be divided into smaller units. The sub-basin outlines will be digitized into the database both to allow display and to enable their areas to be calculated.

When the data has been downloaded into model format, test simulations will be carried to check that the model runs correctly and that volume balances are maintained during simulations. Once this has been established the process of model calibration will start. This is an iterative process which matches the model response to selected dry weather and rainfall events to that recorded by the flow monitors. Calibration is based on the fine tuning of four separate components; base sanitary flow, the diurnal profile exhibited by this component, groundwater infiltration present during dry weather and rainfall derived inflow and infiltration. Once it is believed that calibration has been achieved the model will be verified by confirming that it correctly predicts the measured responses to storms other than used for calibration.

Base Sanitary Flow

For each sub-basin a base sanitary flow, based on estimated residential population and industrial and commercial properties, will be derived. This flow will be in terms of an average over 24 hours and will be input into the model at an appropriate manhole.

Diurnal Pattern

A diurnal profile will be applied to the base sanitary flow calculated above. An initial profile will be derived using the data from flow monitors which recorded flows from purely residential areas. Additional profiles will be developed as necessary to allow for areas with mixed residential, industrial and commercial properties. Several different diurnal profiles can be specified in a single simulation in HydroWorks with each sub-basin being allocated its appropriate profile by means of a Land Use Index. The HydroWorks software allows for different diurnal profiles to be specified for weekdays and weekends if these prove to be significantly different.

Groundwater Infiltration

Cracks in pipes, broken joints an other defects in the sewers permit the ingress of groundwater into the sewer system. This groundwater infiltration (GWI) is usually present at all times but the rate of ingress may vary gradually with time due to changes in groundwater levels, river stages and soil moisture. The amounts of GWI present under dry weather flow conditions can only be estimated from the flow monitoring data. Data from each flow monitor will be analyzed to determine the amount of ground water infiltration present using the following formula:

$$GWI = \text{Average Measured Flow} - \frac{(\text{Average Measured Flow} - \text{Minimum Measured Flow})}{(1 - \text{Night Flow Factor})}$$

The amount of GWI calculated will be distributed into the contributing sub-basins pro rata on area.

GWI will be entered as a separate input. In this way the levels can be easily changed if long term monitoring shows the amount changes significantly with season.

Rainfall Derived Inflow and Infiltration

By definition rainfall derived inflow and infiltration (RDI/I) occurs only during and immediately following storm events. The term RDI/I is used to encompass both components of rainfall which enter the sewer rapidly, inflow, and components which enters more slowly, infiltration. The net storm hydrograph due to RDI/I will be assumed to be composed of three components.

The first component will be a fast response component which routes some rainfall into the sewers in a matter of minutes. This component is usually due to downpipes from roofs being directly connected to the sanitary sewer or other illegal connections where drainage from driveways and yards has been connected in response to flooding problems. The inflows from these directly connected areas tend to fall off quickly once rainfall ceases.

A second component is a medium response which enters the sewer system more slowly by seepage through cracks in manholes and other sewer fittings.

The final component is a slow response which may be imagined as due to the gradual increase and decline in groundwater levels after the storm. The groundwater levels decline due to seepage into the sewers through misaligned joints and cracks in the pipes. Analysis of flow monitoring data suggests the decline in this slow component in the New Orleans system could take 2 to 3 days.

In the model, the volume of rainfall which enters the sewer system will be determined by allocating a percentage of each sub-basin area to each of the three components. The rate at which the rainfall enters the sewer system will be controlled by routing constants which will differ for the three components. Calibration of the model will be achieved by adjusting the percentage area and routing constant for each component until there is satisfactory agreement between model prediction and measured response over a number of rainfall events. If one of the components proves to have negligible effect, calibration of the model may be achieved with the use of only two components.

Another aspect which the long term monitoring can evaluate is the relationship of the volume of RDI/I to the antecedent wetness of the sub-basin. If a significant relationship is demonstrated then a hydrologic routing model which allows for this will be used. The HydroWorks software includes a number of options for this type of routing model.

Finally an allowance will be made in the model to represent the storage volume provided by the unmodeled 6, 8 and 10 inch pipes and associated manholes so that the drain out effect at the end of a storm can be correctly represented.

RUN MODEL FOR RAINFALL EVENTS

The verified model will be used to simulate the effects of the rainfall events chosen for analysis. The output will be reviewed to identify areas of surcharge and overflow and to locate bottlenecks in the system. These locations will be correlated to known problem areas from the records of service requests.

Once problems are identified, the model will be used to develop and test out solutions. Possible solution options would include local storage, sewer upsizing or relief sewers and/or increases in pump station capacity and I/I reduction. The benefits of introducing Real Time Control to optimize the sequencing of pumping stations will also be evaluated. Real Time Control is a relatively new concept which aims at maximizing the performance of existing assets. Details of the status of each pumping station will soon be obtainable in real time when installation of the SCADA system is completed. This will enable a pump to look not only at local conditions but globally before deciding whether to switch on or off. By using the Hydroworks software to develop control rules it may be possible to maximize the capacity of the manifolded force mains by limiting the number of pumps which are switched on at any one time.

DEVELOP BASE FACILITIES PLAN

At this point the outputs from the model simulations will be correlated with the findings of independent structural investigations. Where a sewer line has been determined to be in need of rehabilitation for structural reasons, reference to the outputs from the sewer model may confirm that relining would be adequate or that the sewer should be replaced with a larger pipe to overcome hydraulic problems. Frequency of service requests and future changes in flows because of development will also be taken into consideration in determining the cost effective solution in each basin. The range of options required to reach a cost effective solution is likely to be different in each of the major basins in the sewer system

REHABILITATION FOR COST EFFECTIVE I/I REMOVAL

Where model calibration has indicated a large proportion of directly connected areas (fast response areas) removal of some RDI/I may be cost effective. The effects on solution options achieved by removing varying amounts of directly connected area can be assessed by running suitably amended sewer models. Cost effective analysis will be accomplished by comparing the reduced cost of relief sewers, pump station and treatment plant expansions and/or storage with the estimated cost of inflow removal.

Experience on other projects has shown that attempts to reduce RDI/I which is calibrated to be from slow response areas is less likely to be cost effective. Nevertheless, analysis will be carried out to determine whether this is still the case for New Orleans.

CORRECTIVE ACTION PLAN

The Corrective Action Plan will combine the Base Facilities Plan and the recommendations of Rehabilitation for I/I Removal in order to arrive at a least cost solution which meets the objectives of the S&WB. These objectives are, improved customer service, protection of water quality, improved structural integrity and affordability. It is important to note that this plan will take into account CSES's completed during development of the corrective action plan. In addition, the plan will be updatable as future CSES's are completed

MODEL DEVELOPMENT AND RESOURCE NEEDS

The model will be developed by Montgomery Watson Americas, Inc. (MW). MW is a leading international environmental engineering firm with significant experience in the application of a wide range of wastewater collection system models. MW's Task Manager for the S&WB Program is Mr. Bob Armstrong. Mr. Armstrong is a recognized expert in the modeling of wastewater collection systems and has extensive experience using HydroWorks. He will supervise a staff of three additional engineers assigned to assist in the development of the model. HydroWorks is PC based software; the necessary computers will be purchased and dedicated to the model development.

SCHEDULE

The key dates for the deliverables from the modeling effort are:

Completion of model building and calibration-December 31, 1998

Use of model to develop corrective action plan-December 31, 1999

An outline schedule of tasks to meet these deadlines is given in Appendix 3.

APPENDIX 1

Sewer System Evaluation and Rehabilitation Program
Sewerage and Water Board of New Orleans
Table 1
Temporary Flow Monitor Locations

Flow Monitor No.	Manhole ID	Street Address	Basin ID
NO-01	56-19	Broadway & Cohn Streets	B
NO-02	55-22	Broadway & Oak Streets	B
NO-03A	27-09	Olive & Eagle Streets	B
NO-03B	27-12	Eagle & Forshey Streets	B
NO-03C	27-09	Olive & Eagle Streets	B
NO-03D	37-23	Olive St. @ Carrollton Ave.	B
NO-04	135-02	4638 Washington Ave. (Compak Food Mart between Jefferson Davis Pkwy. & Earhart Blvd.)	B
NO-05	72-04	2243 State St. (between Clara & Magnolia Streets)	C
NO-06	83-01	2400 Jefferson Ave (median near S. Robertson St.)	C
NO-07A	95-11	Loyola & Cadiz Streets	C
NO-07B	95-01	Loyola & Upperline Streets	C
NO-08	107-02	Marengo & Magnolia Streets	C
NO-09	107-09	Clara & Milan Streets	C
NO-10	107-12	General Pershing @ Willow Street	C
NO-11	116-40	2644 Louisiana Ave. (southbound side near Magnolia Street)	C
NO-12	129-01	Washington Ave. @ S. Robertson St.	C
NO-13	205-15	S. Carrollton Ave. @ Palmyra St. (southbound side)	D
NO-14B	204-03	Canal & S. Cortez Streets	D
NO-14C	191	Banks & Genois Streets	D
NO-14D	189-40	Banks & White Streets	D
NO-15A	188/200	320 Rocheblave St. (between Banks & Palmyra Streets)	D
NO-15B	200-02	Palmyra & Rocheblave Streets	D
NO-16	272-22	St. Peter & North Dorgenois Streets	D
NO-17	285-29	N. Claiborne Ave. (eastbound side) & Gov. Nichols St.	D
NO-18	303-11	St. Bernard Ave. (southbound side) near N. Claiborne Ave.	D
NO-19A	328	Annette & Hope Streets	D
NO-19B	328-21	Annette & N. Rocheblave Streets	D
NO-20	326-22	N. Robertson & Annette Streets	D
NO-21	269-09	Villere & St. Ann Streets	E
NO-22	198-21	Canal St. between N. Robertson & Villere Streets (northbound side)	E

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Flow Monitor No.	Manhole ID	Street Address	Basin ID
NO-23	198-36	Canal @ Villere St. (southbound side)	E
NO-24	180-33	Sugarbowl Drive (Superdome ring road along Poydras Street) between Clara and Robertson Streets	E
NO-25	175-02	Stadium Drive (Superdome ring road along N. Claiborne Ave.) near Girod Street	E
NO-26	143-07	2720 Thalia Street (between Clara & Magnolia Streets)	E
NO-27	143-11	Willow & Thalia Streets	E
NO-28	143-27	Felicity and Magnolia Streets	E
NO-29	143-50	2621 Jackson Ave. (between Clara & Magnolia Streets)	E
NO-30A	404-12	N. Miro & Independence Streets	G
NO-30B	404-04	2201 N. Miro Street (@ Alvar Street	G
NO-31	435-19	Japonica & Villere Streets	G
NO-32	435-63	N. Rampart St. & Jourdan Road	G
NO-33	435-34	Jourdan Road @ Urquhart St. (northbound side)	G
NO-36	08-09	201 Country Club Drive (near Cherlyn St.	A
NO-37A	10-02	Fleur de Lis between Leslie Lane & W. Harney Street (southbound side)	A
NO-38	10-22	Fleur de Lis @ W. Harney St. (northbound)	A
NO-39	235-10	Service Alley between Gen. Diaz and Memphis Streets, south of Mouton St.	A
NO-40	235-01	Memphis Street south of Filmore Ave. (in front of PS #21)	A
NO-41	235-01	Memphis Street south of Filmore Ave. (in front of PS #21)	A
NO-42	230-02	Florida Blvd. @ Ada Place (eastbound side)	A
NO-43	220-03	5120 Vicksburg St. (between Florida Blvd. & I-610)	A
NO-44A	247-08	Athis & Perlita Streets	A
NO-44B	245-12	Perlita & Mithra Streets	A
NO-44C	245-22	1420 Prentiss Ave. (between Perlita & Cartier Streets)	A
NO-46	297-02	Milton & Jumonville Streets	A
NO-47	297-02	Milton & Jumonville Streets	A
NO-48	355-02	Selma St. near Spain St. (in front of PS #17)	F
NO-49	356-01	Mandeville & Mithra Streets	F
NO-50A	334-07	Frenchman & Timoleon Streets	F

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Flow Monitor No.	Manhole ID	Street Address	Basin ID
NO-50CA	369-38	2350 Lavender Street (near Iris Street)	F
NO-50C	352-45	Spain & Lombard Streets	F
NO-50D	334-20	Mirabeau Ave & Frenchman St.	F
NO-51	349-01	Treasure & Arts Streets	F
NO-52	369-01	Clematis & Bay	F
NO-53	388-05	Abundance & St. Ferdinand Streets	F
NO-54A	250-22	Mithra & Feliciana Streets	F
NO-55	250-03	Louisa St. (unpaved extension) & Dwyer Rd. drainage canal (south side)--near PS #23	F
NO-56	251-01	Dwyer Rd. drainage canal ROW (north side) between Congress Dr.	F
NO-57	475-12	4936 Papania (between Vienna & Pressburg)	J
NO-58	475-05	Dwyer Rd. drainage canal ROW (south side) between Nottingham Dr. & Read Blvd.	J
NO-59	A33-04	4021 Lennox Blvd. (between Everglades Drive and Norman Canal),	H
NO-60	A33-08	Lennox Blvd. at Brechtel Memorial Park entrance (south of Norman Canal)	H
NO-61A	477-16	In front of Lake Forest Baptist church across from 8800 Morrison Road	I
NO-62A	469-02	9902 Morrison Road	I
NO-63A	477-45	7422 Burke St. between Morrison Rd. & Adele St.	I
NO-64	469-03	Morrison & Bundy Roads (westbound side)	I

Sewer System Evaluation and Rehabilitation Program
Sewerage and Water Board of New Orleans
Table 2
Temporary Rain Gauge Locations

Rain Gauge No.	S&WB Location Map No.	Street Address	Basin ID
RG-1	235	PS #21: Memphis St. @ Filmore Ave.	A
RG-2	230	PS #18: Ada Place between Florida Blvd. & I-610	A
RG-3	24	S&WB Engineering Building (Carrollton Plant)	B
RG-4	54	Tulane University United Campus Ministry Center: 7102 Freret St. (near Audubon)	B
RG-5	86	5353 Laurel St. (N.O. Lawn Tennis Club) near	C
RG-6	107	PS #14: Clara St. between Marengo & Gen. Taylor	C
RG-7	216	3501 Toulouse St. (Armstrong's Supply Company) near N. Jefferson Davis Pkwy.	D
RG-8	247	PS #22: Perlita St. between Athis St. & Prentiss	A
RG-9	297	PS #19: Milton St. @ St. Bernard Ave.	A
RG-10	201	2627 Canal St. (Mrs. Drake Sandwiches) near N. Dorgenois St.	D
RG-11	155	2000 Martin L. King Blvd. (N.O. Fire Station #16) near Rampart St.	E
RG-12	328	PS #9: Law & Annette Streets	D
RG-13	250	PS #23: Mithra St. near Feliciana St.	F
RG-14	366	S&WB Building in front of Operations Building: 2800 Peoples Ave.	F
RG-15	404	PS #16: N. Miro St. near Pauline St.	G
RG-16A	477	PS #3: Burke @ Morrison Rd.	I
RG-17	475	Gentilly Oaks PS: 5000 Papania Dr. (@ Vienna St.)	J
RG-18	435	PS "B": Marais St. between Jourdan Rd. & Sister	G
RG-19	355	PS #17: Spain & Selma Streets	F
RG-20	A33	Park Timbers PS: Lennox Blvd near Norman Canal	H

Sewer System Evaluation and Rehabilitation Program
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Table 3
High Water Locations

High Water Level Indicator	Manhole ID	Street Address	Basin ID
NO-HW-01	33-39	Dante @ Birch	B
NO-HW-06A	82-10	Saratoga @ Octavia	C
NO-HW-06B	89-02	Daneel & Valmont	C
NO-HW-08A	106-20	Milan St. @ S. Liberty St.	C
NO-HW-08B	106-26	Gen. Taylor @ S. Liberty St.	C
NO-HW-13A	205-40	Solomon & Beinville	D
NO-HW-13B	193-08	Solomon & Baudin	D
NO-HW-16A	288-38	Broad & St. Philip	D
NO-HW-16B	289-01	N. Dupre & St. Philip	D
NO-HW-19A	309-01	Allen St. @ N. Miro	D
NO-HW-19B	327-01	Touro St. @ N. Miro	D
NO-HW-19C	347-07	N. Tonti St. @ Marigny	D
NO-HW-20	345-26	N. Robertson & N. St Roch	D
NO-HW-21	268-09	St. Ann & N. Rampart	E
NO-HW-24	172-19	Carondelet @ Girod	E
NO-HW-26	161-13	Clio @ St. Charles	E
NO-HW-27	133-05	Dorgenois & Thalia	E
NO-HW-29A	140-25	St. Charles & Josephine	E
NO-HW-29B	127-28	St. Charles & Philip	E
NO-HW-30A	385-34	N. Miro @ St. Ferdinand	G
NO-HW-31	402-35	Villere St @ Gallier St.	G
NO-HW-34A	450-02	N. Tonti & Alabo	G
NO-HW-34B	457-21	Tonti N. @ Trico	G
NO-HW-39A	238	Robert E. Lee @ Marconi	A
NO-HW-39B	236-46	Robert E. Lee @ Gen. Haig	A
NO-HW-39C		761 Robert E. Lee	A
NO-HW-46A	297-23	Senate & Duplessis	A
NO-HW-46B	297-17	Milton & Gibson	A
NO-HW-49A	356-16	Odin & Marigny	F
NO-HW-49B	356-08	Odin & Spain	F
NO-HW-49C	356-28	Mandeville & Mendez	F

APPENDIX 2

Sewer System Evaluation and Rehabilitation Program
Sewerage and Water Board of New Orleans
Table 4
Permanent Flow Monitor Locations

Flow Monitor No.	Manhole ID	Street Address	Basin ID
NO-02	55-22	Broadway & Oak Streets	B
NO-03A	27-09	Olive & Eagle Streets	B
NO-03B	27-12	Eagle & Forshey Streets	B
NO-03C	27-09	Olive & Eagle Streets	B
NO-04	135-02	4638 Washington Ave. (Compak Food Mart between Jefferson Davis Pkwy. & Earhart Blvd.)	B
NO-05	72-04	2243 State St. (between Clara & Magnolia Streets)	C
NO-06	83-01	2400 Jefferson Ave (median near S. Robertson St.)	C
NO-09	107-09	Clara & Milan Streets	C
NO-11	116-40	2644 Louisiana Ave. (southbound side near Magnolia	C
NO-12	129-01	Washington Ave. @ S. Robertson St.	C
NO-13	205-15	S. Carrollton Ave. @ Palmyra St. (southbound side)	D
NO-17	285-29	N. Claiborne Ave. (eastbound side) & Gov. Nichols St.	D
NO-18	303-11	St. Bernard Ave. (southbound side) near N. Claiborne	D
NO-20	326-22	N. Robertson & Annette Streets	D
NO-21	269-09	Villere & St. Ann Streets	E
NO-22*	198-21	Canal St. between N. Robertson & Villere Streets (northbound side)	E
NO-23*	198-36	Canal @ Villere St. (southbound side)	E
NO-24	180-33	Sugarbowl Drive (Superdome ring road along Poydras Street) between Clara and Robertson Streets	E
NO-25	175-02	Stadium Drive (Superdome ring road along N. Claiborne Ave.) near Girod Street	E
NO-26	143-07	2720 Thalia Street (between Clara & Magnolia Streets)	E
NO-27	143-11	Willow & Thalia Streets	E
NO-28	143-27	Felicity and Magnolia Streets	E
NO-29*	143-50	2621 Jackson Ave. (between Clara & Magnolia Streets)	E
NO-30A	404-12	N. Miro & Independence Streets	G
NO-31	435-19	Japonica & Villere Streets	G
NO-40	235-01	Memphis Street south of Filmore Ave. (in front of PS	A
NO-41	235-01	Memphis Street south of Filmore Ave. (in front of PS	A
NO-48	355-02	Selma St. near Spain St. (in front of PS #17)	F

*Removed for CBD SSES

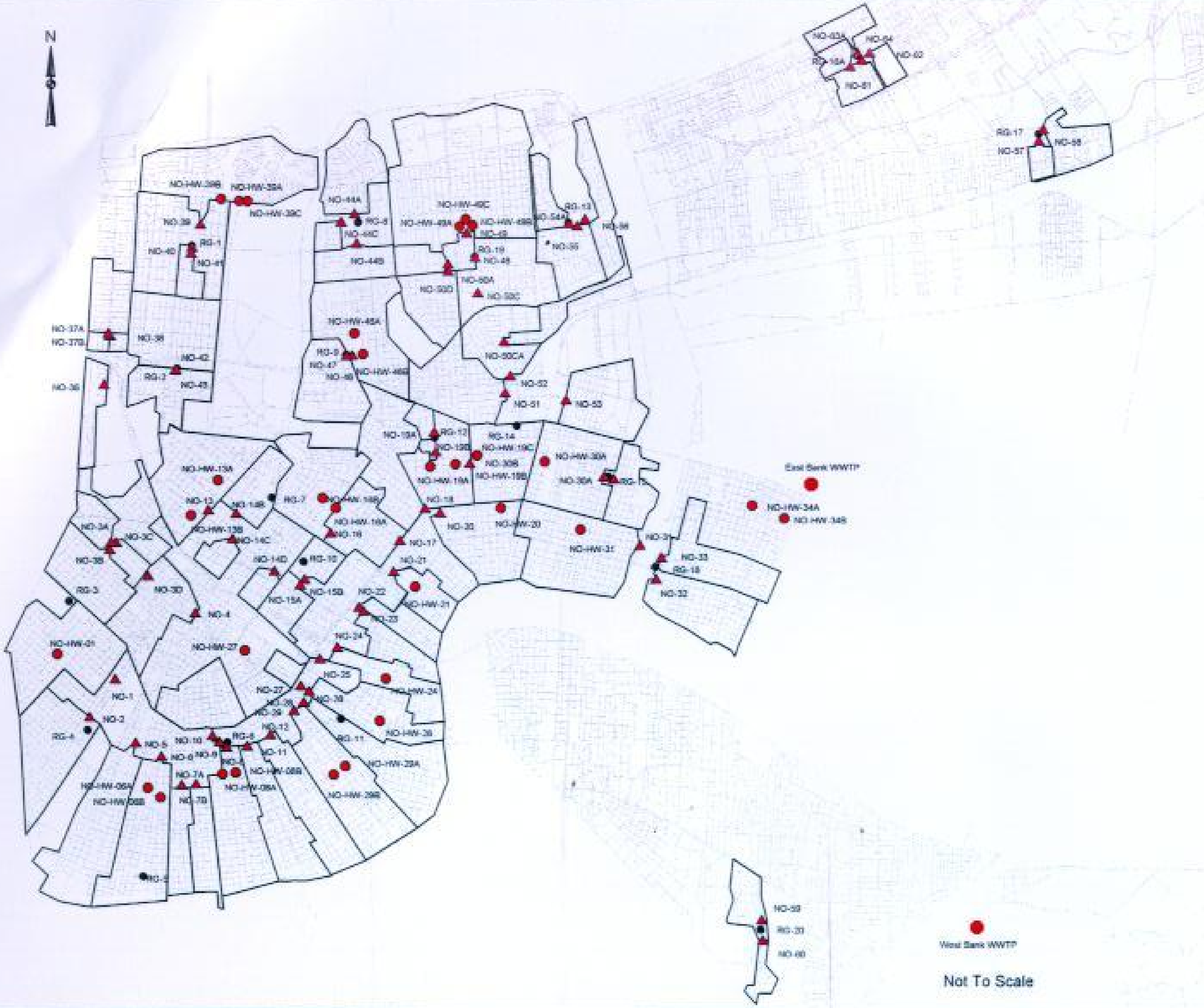
Sewer System Evaluation and Rehabilitation Program
Sewerage and Water Board of New Orleans
Table 4
Permanent Flow Monitor Locations

Flow Monitor No.	Manhole ID	Street Address	Basin ID
NO-40	235-01	Memphis Street south of Filmore Ave. (in front of PS #21)	A
NO-41	235-01	Memphis Street south of Filmore Ave. (in front of PS #21)	A
NO-48	355-02	Selma St. near Spain St. (in front of PS #17)	F
NO-51	349-01	Treasure & Arts Streets	F
NO-52	369-01	Clematis & Bay	F
NO-53	388-05	Abundance & St. Ferdinand Streets	F

*Removed for CBD SSES

Sewer System Evaluation and Rehabilitation Program
Sewerage and Water Board of New Orleans
Table 5
Permanent Rain Gauge Locations

Rain Gauge No.	S&WB Location Map No.	Street Address	Basin ID
RG-3	24	S&WB Engineering Building (Carrollton Plant)	B
RG-4	54	Tulane University United Campus Ministry Center: 7102 Freret St. (near Audubon)	B
RG-6	107	PS #14: Clara St. between Marengo & Gen. Taylor	C
RG-7	216	3501 Toulouse St. (Armstrong's Supply Company) near N. Jefferson Davis Pkwy.	D
RG-10	201	2627 Canal St. (Mrs. Drake Sandwiches) near N.	D
RG-11	155	2000 Martin L. King Blvd. (N.O. Fire Station #16) near Rampart St.	E
RG-12	328	PS #9: Law & Annette Streets	D
RG-14	366	S&WB Building in front of Operations Building: 2800 Peoples Ave.	F
RG-15	404	PS #16: N. Miro St. near Pauline St.	G
RG-18	435	PS "B": Marais St. between Jourdan Rd. & Sister St.	G
RG-19	355	PS #17: Spain & Selma Streets	F



- High Water Level Monitor
- Flow Monitor Location
- Rain Gauge Location
- Waste Water Treatment Plant Location
- Flow Monitor Subbasin Area Boundary
- Streets

Sewer System Evaluation & Rehabilitation Program

Temporary Flow Monitoring Program

Location of Temporary Flow Monitors, Rain Gauges and High Water Level Monitors

SEWERAGE & WATER BOARD OF NEW ORLEANS

MONTGOMERY WATSON

Figure 1

APPENDIX 3

Sewer System Evaluation and Rehabilitation Program

Schedule for Model Building and Analysis

Act ID	Description	Early Start	Early Finish
1000	Pump Station Testing and Evaluation	09DEC96 A	08APR97 A
1010	Temporary Flow Monitoring Survey	27FEB97 A	23APR97 A
1020	Permanent Flow Monitoring Survey	01AUG97 A	31JUL99 A
1030	Digitization of Sewer Records	16JUN97 A	26SEP97 A
1040	Field Survey of manhole Location and Evaluation	09JUN97 A	09NOV97 A
1050	Definition of Sub-basins	29SEP97 A	31DEC97 A
1060	Build the Model	01JAN98 A	31MAR98 A
1070	Determine Dry Weather Base Flows	01APR98 A	30JUN98 A
1080	Calibrate Model to Wet Weather Responnses	01JUL98 A	31DEC98 A
1085	Completion of Model		31DEC98 A
1090	Run Model for Selected Design Storms	01JAN99 A	31MAR99 A
1100	Develop Base Facilities Plan	01APR99 A	30JUN99 A
1110	Determine Cost-effectiveness of I/I Removal	01JUL99 A	30SEP99 A
1120	Develop Corrective Action Plan	01OCT99 A	31DEC99 A
1130	Completion of Corrective Plan		31DEC99 A