West Fork San Jacinto River and Lake Creek Watershed Protection Plan
Quality Assurance Project Plan

Houston-Galveston Area Council
Houston, TX 77077

Funding Source:

Nonpoint Source Program CWA §319(h)
Prepared in cooperation with the Texas Commission on Environmental Quality
and the U.S. Environmental Protection Agency
Federal ID # 99614619
QTRAK#_____

Effective Period: Three years from date of final approval

Questions concerning this QAPP should be directed to:

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SECTION A: PROJECT MANAGEMENT

A1 Approval Page:

Texas Commission on Environmental Quality (TCEQ)

Monitoring Division
Laboratory and Quality Assurance Section

_____
Sharon R. Coleman, TCEQ QA Manager Date

_____
Sandra Arismendez, Lead NPS QA Specialist Date
Quality Assurance Team

Water Quality Planning Division

_____
Kyle Girten, Team Leader Date
Nonpoint Source Program

_____
Jessica Uramkin, NPS QA Specialist Date
Nonpoint Source Program

_____
Jessica Uramkin, TCEQ NPS Project Manager Date
Project Manager, Nonpoint Source

Houston-Galveston Area Council (H-GAC)

Justin Bower, Project Manager, Date	Jean Wright, QA Officer Date
Thushara Ranatunga, Lead Modeler Date	William Hoffman, Data Manager Date

H-GAC will secure written documentation from additional project participants stating the organization's awareness of and commitment to requirements contained in this quality assurance project plan and any amendments or revisions of this plan. H-GAC will maintain this documentation as part of the project's quality assurance records. This documentation will be available for review. Copies of this documentation will also be submitted as deliverables to the TCEQ NPS Project Manager within 30 days of final TCEQ approval of the QAPP. (See sample letter in Attachment 1 of this document.)

A2 TABLE OF CONTENTS

A3 DISTRIBUTION LIST

The Lead Nonpoint Source (NPS) Quality Assurance Specialist (QAS) will provide original versions of this project plan and any amendments or revisions of this plan to the TCEQ NPS Project Manager and the H-GAC Project Manager. The TCEQ NPS Project Manager will provide copies to the TCEQ Data Management and Analysis Team Leader and U.S. Environmental Protection Agency (EPA) Project Officer within two weeks of approval. The TCEQ NPS Project Manager will document receipt of the plan and maintain this documentation as part of the project's quality assurance records. This documentation will be available for review in the event of an audit.

U.S. Environmental Protection Agency Region 6
Water Quality Protection Division
Assistance Program Branch
1445 Ross Avenue
Suite # 1200
Dallas, TX 75202-2733

Anthony Suttice, Project Officer
(214) 665-8590

H-GAC will provide copies of this project plan and any amendments or revisions of this plan to each project participant defined in the list below. H-GAC will document receipt of the plan by each participant and maintain this documentation as part of the project's quality assurance records. This documentation will be available for review in the event of an audit.

Houston-Galveston Area Council
3555 Timmons Lane, Suite 120
Houston, Texas 77027

Justin Bower, Project Manager
(713)-499-6653

Jean Wright, Quality Assurance Officer
(713)-499-6660

Thushara Ranatunga, Lead Modeler
(832) 681-2551

William Hoffman, Data Manager
(832) 681-2574

A4 PROJECT/TASK ORGANIZATION

TCEQ

Monitoring Division

Sandra Arismendez, Lead NPS QA Specialist
Assists the TCEQ Project Manager in quality assurance (QA) related issues. Participates in the planning, development, approval, implementation, and maintenance of the Quality Asssurance Project Plan (QAPP). Determines conformance with program quality system requirements. Coordinates or performs audits, as deemed necessary and using a wide variety of assessment guidelines and tools. Concurs with proposed corrective actions and verifications. Provides technical expertise and/or consultation on quality services. Recommends to TCEQ management that work be stopped in order to safe guard project and programmatic objectives, worker safety, public health, or environmental protection.

Water Quality Planning Division

Kyle Girten, Team Leader
NPS Program
Responsible for management and oversight of the TCEQ NPS Program. Oversees the development of QA guidance for the NPS program to be sure it is within pertinent frameworks of the TCEQ. Monitors the effectiveness of the program quality system. Reviews and approves all NPS projects, internal QA audits, corrective actions, reports, work plans, and contracts. Enforces corrective action, as required. Ensures NPS personnel are fully trained and adequately staffed.

Jessica Uramkin
TCEQ NPS Project Manager
Maintains a thorough knowledge of work activities, commitments, deliverables, and time frames associated with projects. Develops lines of communication and working relationships between the contractor, the TCEQ, and the EPA. Tracks deliverables to ensure that tasks are completed as specified in the contract. Responsible for ensuring that the project deliverables are submitted on time and are of acceptable quality and quantity to achieve project objectives. Serves on planning team for NPS projects. Participates in the development, approval, implementation, and maintenance of the QAPP. Conducts independent technical review of the QAPP to ensure compliance with project needs and requirements. Responsible for verifying that the QAPP is followed by the contractor. Notifies the TCEQ Lead NPS QAS of particular circumstances which may adversely affect the quality of data derived from the collection and analysis of samples. Monitors and enforces corrective action.

Jessica Uramkin
NPS Quality Assurance Specialist
Assists Lead QAS with NPS QA management. Serves as liaison between NPS management and Agency QA management. Responsible for NPS guidance development related to program quality assurance. Serves on planning team for NPS projects. Participates in the development, approval,

implementation, and maintenance of the QAPP.

H-GAC

Justin Bower
H-GAC Project Manager
Responsible for ensuring tasks and other requirements in the contract are executed on time and are of acceptable quality. Monitors and assesses the quality of work. Coordinates attendance at conference calls, training, meetings, and related project activities with the TCEQ. Responsible for verifying the QAPP is followed and the project is producing data of known and acceptable quality. Ensures adequate training and supervision of all monitoring and data collection activities. Complies with corrective action requirements. Works with the Data Manager and Lead Modeler to ensure acquired data meets data quality objectives, modeling is conducted in accordance with this QAPP, and data and model products are backed up appropriately.

Jean Wright
H-GAC Quality Assurance Officer (QAO)
Responsible for coordinating development and implementation of the QA program. Responsible for writing and maintaining the QAPP. Responsible for maintaining records of QAPP distribution, including appendices and amendments. Responsible for maintaining written records of sub-tier commitment to requirements specified in this QAPP. Responsible for identifying, receiving, and maintaining project quality assurance records. Responsible for coordinating with the TCEQ QAS to resolve QA- related issues. Notifies the contractor Project Manager and TCEQ Project Manager of particular circumstances which may adversely affect the quality of data. Responsible for validation and verification of all data collected according with Table 4 procedures and acquired data procedures after each task is performed. Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques. Conducts laboratory inspections. Develops, facilitates, and conducts monitoring systems audits.

Thushara Ranatunga
H-GAC Lead Modeler
The Lead Modeler is responsible for the operation of all computer models and associated documentation of model operation. Responsible for accuracy of input data to models. Performs operation of the models to ensure valid results are being predicted. Responsible for formulating model input to reflect the scenarios and situations to be emulated by each model.

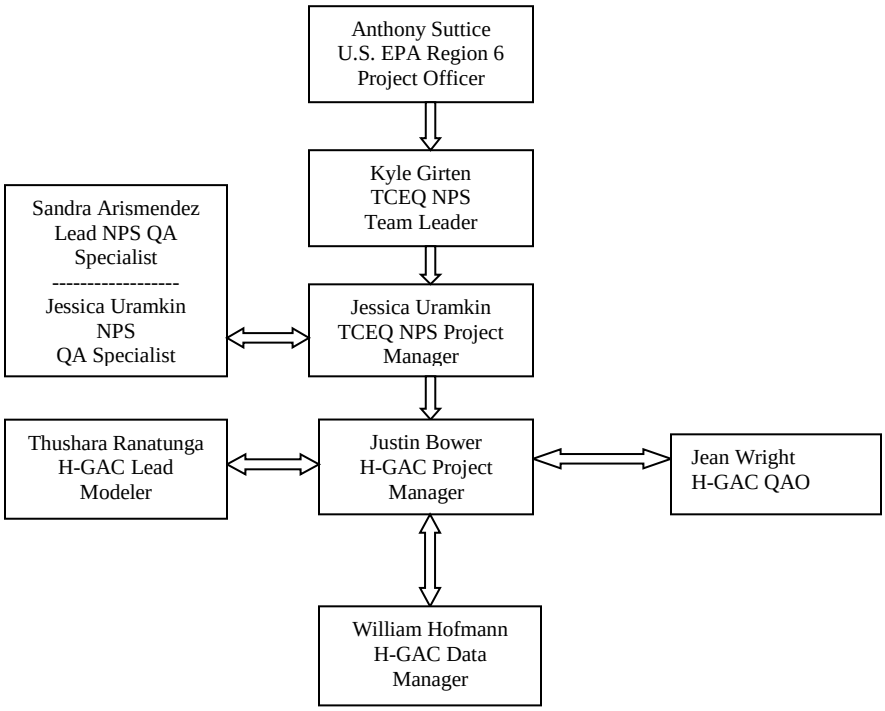
William Hoffman
H-GAC Data Manager
The Project Data Manager is responsible for acquisition and verification of data, documentation of data sources, ensuring the accuracy of data, and for the transfer of data to the TCEQ. Responsible for maintaining project quality assurance records. Oversees data management for the study. Performs data quality assurances prior to transfer of data to the TCEQ. Responsible for transferring data to the TCEQ in an acceptable format. Ensures data are submitted according to work plan specifications. Provides the point of contact for the TCEQ Data Manager to resolve

issues related to the data.

U.S. EPA Region 6

Anthony Suttice
EPA Project Officer
Responsible for managing the CWA Section 319 funded grant on behalf of EPA. Assists the TCEQ in approving projects that are consistent with the management goals designated under the State's NPS management plan and meet federal guidance. Coordinates the review of project workplans, draft deliverables, and works with the State in making these items approvable. Meets with the State at least semi-annually to evaluate the progress of each project and when conditions permit, participates in a site visit on the project. Fosters communication within EPA by updating management and others, both verbally and in writing, on the progress of the State's program and on other issues as they arise. Assists the regional NPS coordinator in tracking a State's annual progress in its management of the NPS program. Assists in grant close-out procedures ensuring all deliverables have been satisfied prior to closing a grant.

Figure A4.1. Organization Chart - Lines of Communication



A5 PROBLEM DEFINITION/BACKGROUND

The watershed of segment 1004, the West Fork San Jacinto River (West Fork) includes three major tributary waterways: Lake Creek (segment 1015), Spring Creek (Segment 1008), and Cypress Creek (segment 1009). In turn, the West Fork is a primary tributary of Lake Houston, a crucial drinking water source and recreation destination in the Houston area. The specific project area for this effort includes the designated segments referenced above, comprising the drainage area for the West Fork south of the dam at Lake Conroe[1].

The northern aspects of the watershed are primarily rural or undeveloped land uses, with the exception of the City of Conroe urbanized area. Areas in the southern part of the project area, including Cypress Creek on the border of urban Harris County, have a greater amount of developed area. The project area is shown in Figure A5.1.

[1] While the Lake and its upstream tributaries could potentially impact the water quality in the project area, the settling and dilution impacts of the lake Conroe reservoir, as well as data reviewed in the previously completed Lake Conroe Watershed Protection Plan conducted by the San Jacinto River Authority, indicate that water quality levels at the dam (boundary conditions for this project area) are meeting standards with additional assimilative capacity. For these reasons, this project area and modeling effort will not focus on the drainage area upstream of the dam.

Figure A5.1. West Fork San Jacinto River Watershed Project Area

Portions of the waterways of this project are listed as impaired for various water quality standards in the 2012 and draft 2014 Integrated Reports, most prominently due to elevated levels of indicator bacteria but also for depressed dissolved oxygen (DO). Some of the waterways are also listed for nitrate, depressed DO, impaired fish communities, ammonia, chlorophyll-a, bacteria, nutrients, and total phosphorus concerns. These impairments and concerns are summarized in Table A5.1 below.

Table A5.1. Summary of Impairments and Concerns for the West Fork San Jacinto River Project Area

Segment ID	2012 Impairments	2014 Impairments	2012 Concerns	2014 Concerns
1004	Bacteria (5a)	Bacteria (5a)	Nitrate (CS), Orthophosphorus (CS)	Nitrate (CS)
1004d	*Bacteria (5a)*	*Bacteria (5a)*		
1004e	*Bacteria (4a)*	*Bacteria (4a)*		
1008	Depressed Dissolved Oxygen (5c), Bacteria (4a)	Depressed Dissolved Oxygen (5c), Bacteria (4a)	Depressed Dissolved Oxygen (CS), Impaired Fish Community (CN), Nitrate (CS), Orthophosphorus (CS), Total Phosphorus (CS)	Depressed Dissolved Oxygen (CS), Impaired Fish Community (CN), Nitrate (CS), Total Phosphorus (CS)
1008A		*Depressed Dissolved Oxygen (5c)*	Depressed Dissolved Oxygen (CS)	Depressed Dissolved Oxygen (CS)
1008B	*Bacteria (5a)*	*Bacteria (4a)*	Nitrate (CS), Orthophosphorus (CS), Total Phosphorus (CS)	Nitrate (CS), Total Phosphorus (CS)
1008C	*Bacteria (5a)*	*Bacteria (4a)*	Depressed Dissolved Oxygen (CS), Nitrate (CS), Orthophosphorus (CS), Total Phosphorus (CS)	Depressed Dissolved Oxygen (CS), Nitrate (CS), Total Phosphorus (CS)
1008E	*Bacteria (5a)*	*Bacteria (4a)*		
1008F			Ammonia (CS), Chlorophyll-a (CS), Nitrate (CS), Nutrients (CN), Orthophosphorus (CS), Total Phosphorus (CS)	Ammonia (CS), Bacteria (CN), Chlorophyll-a (CS), Nitrate (CS), Nutrients (CN), Total Phosphorus (CS)
1008H	*Bacteria (4a)*	*Bacteria (4a)*	Nitrate (CS), Orthophosphorus (CS), Total Phosphorus (CS)	Nitrate (CS), Total Phosphorus (CS)
1008I			Bacteria (CN)	Bacteria (CN), Depressed Dissolved Oxygen (CS)
1008J			Bacteria (CN), Depressed Dissolved Oxygen (CS)	Bacteria (CN), Depressed Dissolved Oxygen (CS)
1009	Bacteria (4a)	Bacteria (4a)	Depressed Dissolved Oxygen (CS), Impaired Habitat (CS), Impaired Macrobenthic Community (CN), Nitrate (CS), Orthophosphorus (CS), Total Phosphorus (CS)	Depressed Dissolved Oxygen (CS), Impaired Macrobenthic Community (CN), Nitrate (CS), Total Phosphorus (CS)
1009C	*Bacteria (4a)*	*Bacteria (4a)*	Nitrate (CS), Orthophosphorus (CS), Total Phosphorus (CS)	Nitrate (CS), Total Phosphorus (CS)
1009D	*Bacteria (4a)*	*Bacteria (4a)*	Ammonia (CS), Nitrate (CS), Orthophosphorus (CS), Total Phosphorus (CS)	Ammonia (CS), Nitrate (CS), Total Phosphorus (CS)
1009E	*Bacteria (4a)*	*Bacteria (4a)*	Depressed Dissolved Oxygen (CS), Nitrate (CS), Orthophosphorus (CS), Total Phosphorus (CS)	Depressed Dissolved Oxygen (CS), Nitrate (CS), Total Phosphorus (CS)
1015			Bacteria (CN), Depressed Dissolved Oxygen (CS)	Depressed Dissolved Oxygen (CS)
1015A		Bacteria (5C)	Bacteria (CN)	

In addition to these existing water quality issues, rapid growth and development is occurring or projected to occur in the project area in the coming decades. Local concern over the advancing degradation of water quality in the project area led H-GAC to propose the development of a watershed protection plan (WPP) for the West Fork San Jacinto Watershed. The WPP will identify and characterize causes and sources of pollution in the watershed through modeling efforts, as informed by stakeholder input and feedback, and identify management measures to address them.

To facilitate the development of the WPP, H-GAC needs to provide sufficient information to guide stakeholder discussion, characterize the causes and sources of pollution in the watershed, and identify the reductions needed to meet state standards, and additional information to achieve other water quality goals identified by the stakeholders[1]. The efforts outlined in this QAPP are designed to generate the information needed to guide decisions, and allow for feedback and revision from the stakeholders. To ensure that the data generated (and subsequent decisions which rely on it) are defensible and of appropriate quality, H-GAC will conduct its modeling and data evaluation tasks in a manner consistent with this QAPP.

The purpose of the QAPP is to clearly delineate H-GAC's QA policy, management structure and procedures to implement the QA requirements necessary to verify, calibrate, and validate the output of the modeling process associated with this project. This QAPP is reviewed by the TCEQ to help ensure that the outputs and data generated for the purposes described within are scientifically valid and legally defensible. This process will facilitate the use of project outputs and data by the NPS program and other programs deemed appropriate by the TCEQ.

A6 PROJECT/TASK DESCRIPTION AND SCHEDULE

The data needs described in A5 relate to characterizing water quality and causes and sources of pollution to guide stakeholder decisions in the development of the WPP. Based on a review of the concerns and impairments, bacteria and depressed DO are the water quality issues of greatest concern to the waterways. In general, the efforts described in this section will be initiated subsequent to approval of this QAPP and completed in quarter 9 of the project period. This project started in July 2015 and is estimated to be completed in August 2018. See Appendix C for a contract schedule of deliverables. All task and deliverable dates are estimates.

Specifically, H-GAC will conduct modeling and data evaluation efforts to:

- evaluate trends and variability in current and historical water quality data, including the use of Statistical Analysis Software (SAS);
- define the spatial distribution and amount of pollutant loading using the Spatially Explicit Load Enrichment Calculation Tool (SELECT) model and Geospatial Load Assessment Methodology (GLAM) tool[2];and
- characterize various pollutant concentrations in varying flow conditions and identify the bacteria reductions necessary to meet applicable standards instream using load duration curves (LDCs).

[1] Water quality goals for this WPP will always include compliance with state water quality standards. Compliance with state standards is always the primary purpose of the WPP, and the development of data therefore. Additional goals may be developed by the stakeholders as part of the public engagement process, for contaminants or issues for which standards and/or numeric criteria do not exist (nutrients, trash, etc.). Data generated under the efforts covered by this QAPP (water quality analysis, etc.) may assist stakeholders in identifying solutions that achieve multiple benefits, or coordinate efforts with existing programs.

[2] For the purposes of this project, the SELECT and GLAM analyses serve the same general purpose; to establish source loads (bacterial for SELECT; nutrients for GLAM). For this purpose, they are referred to in conjunction. throughout the QAPP, although the differences in development and application are detailed.

Water Quality Analysis

The acquisition and analysis of water quality data will be conducted based on existing data in the Surface Water Quality Monitoring Information System (SWQMIS) and data collected during the project under the Clean Rivers Program's (CRP) existing monitoring QAPP. Indicator bacteria, nutrients, temperature, pH, chlorophyll-a, total suspended solids, flow, and DO data will be evaluated for trends, seasonal variation, and spatial patterns. Data for current 24-hour DO monitoring will be reviewed for at least one CRP site in each component watershed. This work will be completed in the timeframe between approval of the QAPP and quarter 7 of the contract. The output of this effort will be the acquired datasets, the trends and variability analyses, a report on the data to be used for modeling efforts, and a report on the trend and variability analyses results. This effort will identify trends, guide decision-making, and provide inputs for the SELECT/GLAM and LDC modeling efforts.

Load Characterization with SELECT/GLAM

The SELECT model (and the GLAM tool for nutrients[1]) will use existing spatial data in a geographic information system (GIS) framework and literature values to characterize the extent and spatial distribution of bacteria sources (SELECT) and nutrient sources related to DO issues (GLAM). These methodologies were selected for this purpose based on use in other similar projects (SELECT), and because they represented a good match between the level of precision needed for the project with the complexity of the model (and the resources available.) Spatial data used in SELECT include land use/land cover, point sources, roads, hydrology/stream network, subwatershed boundaries, aerial imagery, Texas Pollutant Discharge Elimination System (TPDES) permit outfall locations (including wastewater treatment facilities [WWTFs], concentrated animal feeding operations [CAFOs], and municipal separate storm sewer [MS4s] permits), on-site sewage facility (OSSF) locations, soil data, census tracts, regional demographic projections (spatial), elevations, and other related watershed-specific spatial locations (impoundments, etc.). Non-spatial data, or spatial data no used wholly in a spatial context, will include agricultural census data, discharge monitoring reports (DMRs), sanitary sewer overflow (SSO) violation data, wildlife population data, and non-domestic animal population data (feral hogs). Literature values or assumptions derived from data to be used will include population and loading rates for all sources, unpermitted septic system locations, pollutants in WWTF flows, and prevalence of specific sources in different land cover types. Data used in GLAM are limited to hydrologic features and boundaries, basic layers used for map display (road networks, political boundaries), land cover data, and literature assumptions. This work will be completed in the timeframe between approval of the QAPP and quarter 8 of the contract.

SELECT/GLAM will conduct analyses for the project area for current and future conditions. The analyses will be completed for each of the four primary watersheds, and further broken out by subwatershed. An additional set of analyses will be conducted for a scenario in which additional weight is put on the riparian areas to ascertain the relative importance of sources with direct contribution to the waterbodies. Assumptions and results will be reviewed with stakeholders, TCEQ, and other partners to ensure that they reflect local knowledge and provide an accurate

[1] The GLAM tool is a proprietary assessment of nutrient loads generated by varying land cover types. It is not a model, per se. GLAM was developed by H-GAC to provide a general overview of the relative loading of nutrients (N and P) among subwatersheds. The method provides only potential loads based on literature values associated with land cover types, and using existing land cover data.

reflection of loading in the watershed. The output of this effort will be visual displays of loading data, potential load estimates, and characterization of relative contribution by sources for current and future conditions. These outputs will guide stakeholder decisions concerning the identification and prioritization of management measures, and serve as a basis for deriving reduction targets in conjunction with the LDC analyses. GLAM analyses will be limited to assessment of nutrient load based on land cover type, using literature values.

For all analyses, in both current and future conditions, two scenario versions will be run. The first will be a standard application of SELECT/GLAM in which no weighting is given to loads based on proximity to waterways. The second will include a weighting factor in which loads generated within 100 meters of waterways will be weighted as 100%. Loads originating outside this "buffer" area will be weighted as 25%. The "buffered" approach utilizes a weighting factor to accentuate the probability of proximate load to waterways having greater impact[1] Both scenarios are run to evaluate whether proximity should be a consideration for stakeholders in prioritizing sources. For example, if the buffered scenario indicates that OSSFs are a greater amount of the load when proximity is taken into account (e.g. in a waterway in which most OSSFs are located in the riparian corridor), stakeholders may want to focus on this source, even if the standard runs show OSSFs as a lesser relative contribution. The two scenarios are intended to give a high-level view of the potential impacts to loading potential based on distance to stream.

Load Duration Curves

LDCs for bacteria were conducted previously under a Total Maximum Daily Load (TMDL) effort for the East and West Forks of the San Jacinto River[2]. This project effort will develop updated and revised LDCs for bacteria at a selection of the existing TMDL LDC sites, new LDCs for bacteria at additional sites, and generating new LDCs for DO/nutrients. The LDCs will be used to derive load reductions or bacteria and also to evaluate any patterns in exceedances of the water quality standard based on flow conditions for all constituents. This work will be completed in the timeframe between approval of the QAPP and quarter 8 of the contract.

LDCs will be completed for 12 stations in the project watersheds (at least one per watershed), utilizing quality assured water quality data from SWQMIS and/or CRP sources and flow data from USGS gauges. If stakeholders indicate an LDC is needed for an area without sufficient flow data, and there is sufficient flow data available to calibrate a flow estimation model, H-GAC will employ the ArcSWAT model to create a simple hydrological/runoff application that uses existing spatial and climate data to generate a 10-year period of estimated flow data. Prior to developing the LDCs, H-GAC will evaluate the preliminary information from water quality data analyses to confirm that selected LDC sites are appropriate for characterizing their respective water bodies. If additional or amended locations are needed after water quality data analysis is completed, this QAPP will be amended prior to work being initiated on amended locations. The outputs of the

[1] This relationship would be detailed in more complex modeling approaches like SWAT, which are not being utilized for this project. SELECT does not account for the effects of proximity on bacteria transmission, which may skew source contribution ratios and impact stakeholder decisions. The weighting approach is based on previous WPP approaches (Plum Creek, Bastrop Bayou, San Bernard River, Cedar Bayou) using some extent of the same approach, as developed by, and approved by, stakeholders.

[2] As described in the Technical Support Document for this project, located at http://www.tceq.state.tx.us/assets/public/waterquality/tmdl/82sanjacinto/82-sanjac_tsd_2015.pdf

LDC analysis will be visual characterizations of the relationship between flow levels and constituent concentrations, and reduction estimates for constituent loading. The use of this effort will be to help identify variation in loading based on flow and to inform stakeholder decisions regarding scale and type of management measures. The USGS stream gauge and monitoring site locations for LDCs are summarized in Table A6.1.

Table A6.1. LDC Monitoring Site Locations

USGS Gage	Site Description	TCEQ Site ID
08067650	West Fork San Jacinto River below Lake Conroe, near Conroe, TX	11251
08068090	West Fork San Jacinto River below Lake Conroe, near Conroe, TX	11243
08068390	Bear Branch at Research Blvd, The Woodlands, TX	16631
08068275	Spring Creek near Tomball, TX	11314
08068500	Spring Creek near Spring, TX	11313
08068720	Cypress Creek at Katy-Hockley Rd near Hockley, TX	20457
08068740	Cypress Creek at House-Hahl Rd near Cypress, TX	11333
08068800	Cypress Creek at Grant Rd near Cypress, TX	11332
08069000	Cypress Creek near Westfield, TX	11328
NA[1]	Lake Creek near Conroe, TX	11367
NA[2]	Crystal Creek at SH242 Southeast of Conroe	16635
NA[3]	Mound Creek 167 Meters Downstream of Mulligan Road, 1.35 km Upstream of Confluence with Lake Creek	17937

This modeling approach was chosen based on applicability of the models to the project questions; level of precision needed for development of the watershed protection plan; similarity to other WPP modeling efforts; and through discussions with TCEQ project staff. The fundamental goal of these modeling efforts remains to inform staff understanding of the watershed and stakeholder decisions. The timeline for these efforts is defined in the contractual agreement between H-GAC and TCEQ, as amended from time to time, and summarized in Table A6.2.

[1] Flow data will be generated using an application of ArcSWAT due to limited USGS flow gauge data.
[2] Flow data will be generated using an application of ArcSWAT due to lack of USGS flow gauge on this unclassified segment.
[3] Flow data will be generated using an application of ArcSWAT due to lack of USGS flow gauge on this unclassified segment.

Table A6.2. Modeling and Data Analysis Schedule of Deliverables

Contract Task No.	Deliverable	Due Date
3.1	Draft Acquired Modeling Data Report Quarter 4 of the Contract	Quarter 4 of the Contract
3.2	Final Acquired Modeling Data Report Quarter 5 of the Contract	Quarter 5 of the Contract
3.3	Draft Data Collection and Trends Analysis Report Quarter 7 of the Contract	Quarter 7 of the Contract
3.4	Final Data Collection and Trends Analysis Report Quarter 8 of the Contract	Quarter 8 of the Contract
4.1	Modeling Methodology Description Analysis	Quarter 3 of the Contract
4.2	Updated Load Duration Curves	Quarter 8 of the Contract
4.3	SELECT/GLAM Modeling	Quarter 8 of the Contract
4.4	Modeling Support Document (Interim)	Quarter 7 of the Contract
4.5	Draft Modeling Report	Quarter 9 of the Contract
4.5	Final Modeling Report	Quarter 9 of the Contract

Revisions to the QAPP

Amendments

Amendments to the QAPP may be necessary to reflect changes in project organization, tasks, schedules, objectives and methods; address deficiencies and nonconformances; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Requests for amendments are directed from H-GAC's Project Manager to the TCEQ NPS Project Manager in writing using the NPS QAPP Amendment Shell. The changes are effective immediately upon approval by the TCEQ QA Manager, NPS Project Manager and TCEQ QAS or their designees, and the EPA Project Officer.

Amendments to the QAPP and the reasons for the changes will be documented, and full copies of the amendments will be forwarded to all persons on the QAPP distribution list by H-GAC QAO. Amendments shall be reviewed, approved, and incorporated into a revised QAPP during the annual revision process or within 120 days of the initial approval in cases of significant changes.

Annual QAPP Reviews and Revisions

This QAPP shall be reviewed annually by H-GAC's Project Manager. A letter certifying this annual review must be submitted to the TCEQ Project Manager no later than 90 days prior to the QAPP anniversary date. Amendments approved since QAPP approval (or most recent annual review, if applicable) should be included along with the letter as an attachment. Also, if any organizational changes have occurred, these should be conveyed within the certification letter. If

changes (beyond organizational changes) are necessary, a QAPP amendment must be approved before the annual review may be certified. The TCEQ Project Manager is required to provide certification of annual reviews to the TCEQ QA Manager and EPA Region 6 Project Officer no later than 30 days before QAPP anniversary dates. If the QAPP expires, work described within this document must be halted.

If extensive changes are required (as determined by the TCEQ Project Manager, in consultation with the TCEQ Lead QAS), or if the project will extend beyond the third QAPP anniversary date, a full QAPP revision is required. This is accomplished by submitting a cover letter, a document detailing changes made, and three full copies of the fully updated QAPP (including three sets of signature pages).

A7 QUALITY OBJECTIVES AND CRITERIA FOR MODEL INPUTS/OUTPUTS

The general quality objectives for the project are to produce data analysis and modeling outcomes that accurately characterize conditions in the watershed and are a sufficient platform on which to base stakeholder decisions concerning the selection and scale of management measures. This is generally achieved through the use of best available data (quality-assured as applicable), review of products and inputs with stakeholders and knowledgeable partners, and adhering to the preponderance of literature (as amended by reasonable stakeholder review) for modeling assumptions. These goals are fostered by continual and robust engagement with stakeholders, especially partners with specific technical experience.

Data quality objectives for each component effort are described below. For all acquired/existing data sources (See B3) quality assured data from SWQMIS as collected through CRP or other submitting programs will be used if available.

Water Quality Analysis

The primary data quality objectives for this effort are to ensure data inputs are from quality assured sources, and that analysis outputs accurately reflect water quality trends in the watershed. The focus of the analyses are long-term trends, although short-term or seasonal trends may be reviewed based on a review of the available dataset, requirements of the stakeholders, and area-specific circumstances. Performance criteria for inputs are quality-assured status for water quality data (e.g. data collected under existing TCEQ/EPA approved QAPP or other similar source). Data that is not quality assured (e.g., Stream Team volunteer data and findings of the San Jacinto River Authority's watershed protection plan for Lake Conroe) may be used to help characterize the watershed in a qualitative sense, or as indicators where additional analysis may be needed, but will not be considered equal to data produced under QAPP. These data sources will not be used for the water quality analyses or mingled with quality-assured data, but only for informal/informative review of potential problem areas not covered by formal monitoring. Performance criteria for outputs include a proper data management trail (per Appendix A and relevant document retention requirements of this QAPP) of the data evaluation process, and trends/variability analyses that properly utilized SAS methods (See Appendix A), performed by experienced staff. The outputs will be acceptable if the aforementioned performance criteria are met (this is a qualitative measure, as no calibration or validation of data

other than initial validation in submission to SWMQIS is performed on these analyses). The intended use of these outputs will be to display water quality trends for stakeholder decision-making processes, including the development of pollutant reduction targets based on the results of the SELECT and GLAM modeling outputs. Hardware and software to be used will conform to industry standards (e.g. Microsoft Office products and SAS utilized in a Windows 7 environment). Configuration of SAS analyses will be based on similar water quality analyses conducted by CRP staff using the same data management and data evaluation processes and tools to ensure the data is comparable with those of other regional and regulatory efforts. Data completeness will be evaluated based on whether all existing data as submitted to SWQMIS has been used. Data representativeness will be based on whether all available data from stations in the watershed is utilized, thus representing the broadest picture of conditions throughout the area. Because the data and methods to be used have previously been reviewed as part of quality-assured processed, no appreciable bias in the data is expected. Systemic bias in water quality sampling data is based on skewing of data collection to daylight hours. Systemic uncertainty is found in the lack of continuous data (i.e. periodic grab samples under CRP, etc.). However, these sources of uncertainty are endemic to monitoring programs, and are not expected to produce serious issues for data analysis acceptability.

Load Characterization with SELECT/GLAM

The primary data quality objectives for this effort are to ensure data inputs are from the best available sources (quality assured or industry standard), that assumptions are scientifically defensible and vetted by stakeholders, and that outputs are driven by appropriate data and stakeholder review. Performance criteria for inputs are that they represent the best available data, and in the case of data sources which may differ from place to place, the most locally-appropriate data (e.g. deer population numbers for the specific area as opposed to a statewide average) All spatial data used in SELECT/GLAM is from sources that are quality-assured or are widely-used data products appropriate for this task. Performance criteria for outputs include modeling outcomes that are sufficient to guide stakeholder discussion, and which are demonstrably defensible based on the source and vetting of data and assumptions. The outputs will be acceptable if these criteria are met (this is a qualitative measure, as no model calibration or validation of data other than initial validation in submission to SWMQIS is performed for SELECT/GLAM). The intended uses of these outputs will be to generate potential pollutant load estimates and characterize their spatial relationship, and to guide stakeholder discussions of the scope of management measures. Hardware and software to be used will conform to industry standard (e.g. Microsoft Office products, and the SELECT model utilized in a Windows/ArcGIS environment). Configuration of SELECT assumptions analyses will be based on similar SELECT analyses to ensure the data is comparable with those of other regional and regulatory efforts.

Use of literature values for the GLAM assessment will be based on concurrence between H-GAC and TCEQ, as reviewed and amended by stakeholders. However, specific configuration of assumptions will be based on best local data and stakeholder input. Data completeness will be based on whether sufficient data is available to generate loads using the SELECT model and GLAM tool. Data representativeness will be evaluated based on whether spatial data and assumptions are indicative of conditions throughout the watersheds. Because the selection of assumptions and the stakeholder review process can introduce some subjectivity in decision-

making, some level of bias in the outcomes is expected. Bias will be considered reasonable if modifications to outputs or assumptions are based on reasonable expectations that local knowledge or data is more appropriate than more general values. Systemic uncertainty is inherent to the use of assumptions and literature value. However, these sources of uncertainty are endemic to SELECT modeling and the GLAM tool, and do not compromise the objectives for this modeling effort. Neither SELECT nor GLAM are intended to be a model of a precision level that would be impacted by these levels of bias and/or uncertainty. Table A7.1 indicates assumptions or literature values that will be applied to the models.

Table A7.1 Modeling Assumptions

Assumption/ Literature Value	Model	Review with Stakeholders?	Source	Value
Feral Hog density	SELECT	Yes	Texas A&M Agrilife Research (AgriLife) densities.	AgriLife has used a variety of hog densities, with a generic Texas range of 1.3-2.5 hogs per square mile[1], depending on land cover type. This value is expected to be heavily modified by local stakeholders to reflect area or subwatershed populations.
Livestock populations	SELECT	Yes	United States Department of Agriculture National Agricultural Statistics Service (NASS) Agricultural Census data (most recent.)	County-level data is used to derive a ratio of animals per land cover type. This ratio is then applied to the area of the watershed in each county.
OSSFs number and location	SELECT	Yes	H-GAC OSSF database	Permitted systems are based on actual location data. Unpermitted systems are based on occupied locations outside of service areas, without permitted OSSFs.
OSSF failure rates	SELECT	Yes	H-GAC OSSF data, stakeholder input	Base values are developed for different age/permit classes (50% failure rate for systems installed before 1989, and 12%

[1] http://irnr.tamu.edu/media/355507/sp-472.pdf

Assumption/ Literature Value	Model	Review with Stakeholders?	Source	Value
				for those installed after 1989). As these rates are highly variable by location, failure rates will be heavily modified by stakeholder (especially Authorized Agent) input.
Animal excretion/bacterial densities	SELECT	No	Literature value	Based on values indicated in Teague, 2009[1].
WWTF discharge concentrations	SELECT	Yes	DMR data from each plant (TCEQ)	Geomean of DMR data, using an assumed 60% of permitted flow as daily average flow to determine total load.
Land cover change	SELECT, GLAM	Yes	H-GAC regional demographic projections	Proprietary data used in most regional WPPs.
Pet populations	SELECT	Yes	American Veterinary Medicine Association (AMVA)	AMVA estimates of household ownership (0.8 pets/household) used as a starting figure, multiplied by number of households.
Deer Populations	SELECT	Yes	TPWD	TPWD Resource Management Unit (RMU) data is used to define regional deer population estimates, which are applied to appropriate land cover types, as in Teague, 2009.
Bird populations/fecal concentrations	SELECT	Yes	TPWD, Stakeholders, EPA, TSSWCB	Bird populations are based primarily on TPWD staff knowledge (if available) and stakeholder knowledge. Of primary concern are the presence of colonial rookeries, swallow nesting sites over water,

[1] "Spatially explicit load enrichment calculation tool to identify potential E. coli sources in watersheds." A. Teague, et al. 2009. http://ssl.tamu.edu/media/11291/select-aarin.pdf

Assumption/ Literature Value	Model	Review with Stakeholders?	Source	Value
				gulls concentrated at landfills, and other large concentrations of birds. EPA and TSSWCB values[1] for bird fecal rates are used if stakeholder input indicates substantial, or substantially proximate (swallow colonies over bridges, etc), numbers of birds exist on an annual basis to model. Values dependent on species of concern.
WWTF outfall locations	SELECT	No	TCEQ spatial data	WWTF outfalls are spatially explicit data.
Nutrient loads from land cover types	GLAM	Yes	Various; stakeholder input/	For the GLAM tool, nutrient loads are associated with land cover types rather than discrete sources. Nutrient values are taken from existing studies and similar projects[2]. Development of final values is dependent on stakeholder input.

Load Duration Curves

The primary data quality objectives for this effort are to ensure data inputs are from quality assured sources; that modeling assumptions are based on existing TMDL LDCs, best available literature, and best professional judgment; and that outputs reflect load durations and related reduction needs (for bacteria) in a manner that is reflective of the diverse conditions of the project area. Performance criteria for inputs are quality-assured status for water quality data (e.g. data collected under existing TCEQ/EPA approved QAPP or other similar source) and outputs

[1] Based on studies referenced by EPA and TSSWCB, including http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2771205/ and as http://www.tsswcb.texas.gov/files/docs/BBBB_Report_23Sep13_Clean.pdf

[2] The range of literature values will be taken from NRCS data on agricultural land cover nutrient loading (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_013288.pdf, for example), EPA loading estimates (http://www2.epa.gov/sites/production/files/documents/wetlands_19nutrientloading.pdf, etc.), and other values found in similar projects (such as https://www.tacoma.uw.edu/sites/default/files/global/documents/ias/UWaTERS_11/Moore.pdf). The most locally appropriate value will be based on stakeholder input.

from previously approved TMDL LDCs. Performance criteria for outputs include a proper data management trail of the data evaluation process, and LDC analysis using established methods[1], performed by experienced staff. The outputs will be acceptable if these criteria are met (this is a qualitative measure, as no calibration or validation of data other than initial validation in submission to SWMQIS is performed on these analyses).

The intended use of these outputs will be to develop bacteria reductions, and define impacts to bacteria, DO and related constituents under various flow conditions. Hardware and software to be used will conform to industry standards (e.g. Microsoft Office products and LDC approaches [LoadEst, et al.] utilized in a Windows 7 environment). Configuration of LDC assumptions will be based on TCEQ guidance and the existing East and West Fork TMDL LDC analyses to ensure the data is comparable with those of other regional and regulatory efforts. However, specific configuration of assumptions will be based on best available data, professional judgment, and stakeholder review. Data completeness will be based on whether sufficient data is available to generate LDCs. Data representativeness will be evaluated based on whether selected LDC sites have sufficient data, and are representative of the watersheds in general. Because the selection of assumptions and the stakeholder review process can introduce some subjectivity in decision-making, some level of bias in the outcomes is expected. Bias will be considered reasonable if modifications to outputs or assumptions are based on reasonable expectations that local knowledge or data is more appropriate than more general values or specific choices (e.g., level of reduction to be used in relation to bacteria). Systemic uncertainty is inherent to the simplicity of the model and the complexity of real world systems. However, these sources of uncertainty are endemic to LDC modeling and do not compromise the objectives for this modeling effort. LDCs are not intended to be a modeling approach of a precision level that would be impacted by these levels of bias and/or uncertainty. If insufficient USGS flow data is available for sites, estimated flow data will be projected using the Soil and Water Assessment Tool (SWAT). The data objectives for the estimated flow conform to the same intended uses as the other LDC inputs and outputs. The intent of estimating flow is to provide stakeholders with information for an area that may otherwise not have sufficient flow data on which to base an LDC.

A8 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

No formal certification is required for the efforts to be conducted under this QAPP. The modeling and project management staff have conducted previous training in all modeling and data evaluation efforts discussed. Any additional staff members that conduct work under this project will have, or receive, training specific to their work.

The lead modeler and project manager have conducted SELECT and LDC analyses (including the use of SWAT in general and for the specific purpose of generating flow data) on a variety of watershed projects, and have attended multiple formal training events on SELECT and LDCs. Additionally, they have advanced knowledge of data quality needs and objectives common to modeling approaches in general based on past experience and training. The GLAM tool will utilize existing data resources and GIS, so no additional training is required. The SWAT tool will use existing data resources, and staff are already trained in its use and application for these

[1] http://www.epa.gov/tmdl/approach-using-load-duration-curves-development-tmdls

purposes, so no additional training is required.

The data manager and QAO for this project are the H-GAC lead staff for CRP data analysis, and have extensive training in data management, quality assurance, and SAS operation (data manager). They routinely attend training specific to SWQMIS procedures, and/or SAS operation. Their daily activities have heavy focus on this type of data analysis and quality assurance.

All staff members have worked with QAPPs under prior projects. No additional training is expected to be needed to complete the project efforts.

A9 DOCUMENTATION AND RECORDS

All digital and paper documentation for the project is kept for a period of seven years. The H-GAC Project Manager has final responsibility for ensuring project files are compiled in accordance with this QAPP. The QAO and Data Manager will ensure that the PM has appropriate documentation for water quality data analyses and records for data from acquired data sources including but not limited to SWQMIS and CRP data. The Lead Modeler will ensure that all modeling records, notes, literature referenced, and other records from modeling efforts are maintained during the course of the project, and relinquished to the Project Manager for proper retention. Electronic data on the project computers and the network server are backed up daily to the network drive and weekly to external storage. In the event of a catastrophic systems failure, the tapes can be used to restore the data in less than one day's time. Data generated on the day of the failure may be lost, but can be reproduced from raw data in most cases. Quarterly progress reports disseminated to the individuals listed in section A3 will note activities conducted in connection with the water quality modeling project, items or areas identified as potential problems, and any variations or supplements to the QAPP.

In addition to general information regarding data and modeling activities, any stakeholder input received, or notes generated regarding input, will be included with modeling files and project documentation.

Modeling Log

Modeling notes created by the Lead Modeler will be recorded electronically with model files, on paper, or in a separate electronic file (e.g., Word document). All electronic files will be stored in the same folder as the modeling files, and all paper files will be retained by the modeler until the end of the project. At that time they will be included with project files maintained by the Project Manager.

The Lead Modeler will document reasons for model selection not already identified in this QAPP, references for model assumptions (and adjustments thereof), stakeholder feedback, and model runs. The level of detail will be sufficient to allow another modeler to duplicate the modeling method given the same data and model.

The documents and records that describe, specify, report, or certify activities, requirements, procedures, or results for this project and the items and materials that furnish objective evidence

of the quality of items or activities are listed in Table A9.1. All project staff will develop and retain documentation as described in Table A9.1.

Table A9.1 Project Documents and Records

Document/Record	Location	Retention*[a]	Form*[b]
QAPPs, amendments, and appendices	H-GAC	7 years	Paper/Electronic
QAPP distribution documentation	H-GAC	7 years	Paper/Electronic
SOPs	H-GAC	7 years	Paper/Electronic
Model User's Manual or Guide (including application-specific versions)	H-GAC	7 years	Paper/Electronic
Assessment reports for acquired data	H-GAC	7 years	Paper/Electronic
Raw data files	H-GAC	7 years	Paper/Electronic
Model input files	H-GAC	7 years	Electronic
Model output files	H-GAC	7 years	Electronic
Code Verification Reports	H-GAC	7 years	Paper
Interim results from iterative calibration runs	H-GAC	7 years	Electronic
Calibration Report	H-GAC	7 years	Paper
Model Assessment Reports	H-GAC	7 years	Paper
Progress report/Corrective Action Reports (CARs)/final report/data	H-GAC/TCEQ	7 years	Paper/Electronic

*a – After the close of the project
*b – Electronic files should be ASCII/DOS pipe delimited text files or MS Word/Excel; model input and output files can be archived in the format used by the modeling software, provided the capability of conversion to ASCII/DOS pipe delimited text files or MS Word/Excel (TCEQ compatible version) is maintained over the time of retention.

The TCEQ may request records at any time and/or elect to take possession of records at the conclusion of the specified retention period.

SECTION B: MEASUREMENT AND DATA ACQUISITION

The primary source of data for these data analysis and modeling efforts will be SWQMIS data produced under previous QAPPs (e.g. Clean Rivers Program data, etc).

B1 SAMPLING PROCESS DESIGN

Not Relevant – This QAPP does not cover any sample collection activities.

B2 SAMPLING METHODS

Not Relevant - No new sampling data will be collected under this QAPP during this project.

B3 SAMPLE HANDLING AND CUSTODY

Not Relevant - No new sampling data will be collected under this QAPP during this project.

B4 ANALYTICAL METHODS

Not Relevant - No new sampling data will be collected under this QAPP during this project.

B5 QUALITY CONTROL

Not Relevant - No new sampling data will be collected under this QAPP during this project.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

Not Relevant - No new sampling data will be collected under this QAPP during this project.

B7 MODEL CALIBRATION

No formal calibration (or sensitivity analysis) is used for the data analyses (SAS), SELECT, GLAM, or standard LDCs. Informal adjustment of the model inputs or outputs may be applied based on stakeholder feedback and more specific local knowledge compared to general assumptions.

Flow estimation for LDCs in which there is not sufficient USGS continuous flow data will be completed using a simple application of ArcSWAT to generate a simple hydrological runoff model. The intention of this hydrologic model was only to generate flow data, so only a simple calibration was conducted using existing USGS flow data for a two-year period (2002-2004; the only USGS flow data available). The model performance statistics will be evaluated, such as R^2 and Nash-Sutcliffe Coefficient (NSE) to determine the acceptability of the model. Since the intention of this hydrologic model is only to generate the flow data, only a simple calibration will be conducted using major catchment parameters such as Curve number values (CN) and Manning's roughness coefficient. When a satisfactory level of model performances is achieved, the daily flow records for the years from 2005 to 2015 will be extracted and exported for the LDC development.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Not Relevant - No new sampling data will be collected under this QAPP during this project

B9 NON-DIRECT MEASUREMENTS (DATA ACQUISITION REQUIREMENTS)

The modeling and water quality data analysis efforts described in this QAPP will make use of non-direct/acquired data from a variety of sources. The sources and their characteristics are included in Table B9.1.

The primary sources of data for model development are:

- water quality monitoring data from SWQMIS;
- DMRs, SSO violation data, other permit reporting data from TCEQ databases;
- regional demographic forecasting data created by H-GAC;
- OSSF location data created by H-GAC for TCEQ;
- developed data (LDC runs, etc) from the East and West Fork TMDL modeling efforts[1];
- spatial datasets and databases created by other state and federal agencies (e.g. National Oceanic and Atmospheric Administration [NOAA] land cover data, USGS flow data, precipitation data, etc.); and
- literature values for model assumptions (see Table A7.1[1]).

[1] Information from the TMDL LDC process regarding sources, assumptions, stakeholder input, and other factors may be used to inform stakeholder decisions and modeling assumptions/outcomes in this project. However, the LDCs for this project will be rerun using current data.

All non-direct data being used has been previously deemed to be acceptable acquired data sources under other QAPP efforts, or was prepared under QAPP coverage. In all instances, the best available data in terms of quality, quality control, and comparability with other QAPP covered modeling efforts have been selected for use.

Ambient Water Quality Data

No data will be collected specifically for this project nor submitted for inclusion in SWQMIS. The collection and qualification of the TCEQ and USGS data are addressed in the TCEQ Surface Water Quality Monitoring QAPP[2]. The collection and qualification of the Texas CRP data are addressed in the Texas Clean Rivers Program QAPPs[3]. Data acquired for this project will include those parameters described in section A6 as well as any other data needed to characterize the watershed; develop, operate or validate models; or meet other user requirements. These data include conventional parameters, field parameters, bacteriological parameters, and biased sampling conducted under special projects.

TCEQ's SWQMIS is the largest and most complete repository for water quality data collected under accepted QAPP procedures in the State of Texas and was selected for that reason for these efforts. The water quality data to be acquired for this project will include routine water quality data collected by TCEQ and sampling partners such as the CRP, the United States Geologic Survey (USGS), and the Texas State Soil and Water Conservation Board, including available 'non-qualified,' routine or special study, ambient, fixed station water quality data and associated field parameters.

Comparability of methods is based on TCEQ's CRP FY2016-2017 Guidance, Task 5. This document gives guidance for which method codes can be combined and which are considered comparable. The document also suggests methods on how to substitute or censor data reported below quantitation limits. All censored data methods will be evaluated before data is used in the final analyses and fully documented. Assessments of CRP data conducted under the Basin Highlights Report(s) and Basin Summary Report falling within this project timeline may be used to supplement analyses conducted under this project. All CRP work is conducted under its own QAPP, and is not intended to be covered under this QAPP. However, the data, staff, and processes used are identical to those intended for this project.

TCEQ Permit and Violation Data

This project will make use of data from TPDES and other permittees acquired and maintained by TCEQ. This will include DMRs, SSO violation data, TPDES permit information and compliance history, and other data relevant to TCEQ or EPA-permitted facilities in the watershed. This data is assumed to be of acceptable quality based on inclusion in TCEQ- or EPA-approved datasets, including those prepared by H-GAC for TCEQ under QAPP-covered efforts funded by 604(b)

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[1] Table A7.1 includes preliminary model assumptions and literature values. Additional values, assumptions, or modifications thereof may be utilized depending on stakeholder input. The project modeling process relies strongly on working with stakeholders to refine assumptions to best suit local conditions and knowledge.

[2] www.tceq.state.tx.us/waterquality/monitoring/swqm_guides.html

[3] www.tceq.texas.gov/waterquality/clean-rivers/qa/index.html

Water Quality Management Plan projects. H-GAC will work with TCEQ staff to identify, acquire, and update these data sources.

Regional Demographic Forecasting
H-GAC conducts regional demographic forecasting as part of a quality-assured effort. Data to be used for this project include current and future population projections, land cover change projections, and household and job change projections. This data source is the standard for the region, and is used in comparable QAPP-covered planning efforts as well as broader regional planning efforts.

OSSF Location Data
H-GAC maintains a spatial database of permitted OSSF locations for the region, including the project area. This database was developed and maintained under a TCEQ-approved QAPP as part of an ongoing Clean Water Act 604(b) Water Quality Management Plan partnership between H-GAC and TCEQ. Additional data from Grimes County will be incorporated as feasible to cover the entire project area, under the existing 604b QAPP.

Existing TMDL Modeling
The LDCs for the existing East and West Fork TMDL project[1] will be used as a basis for updating and revising LDCs for the corresponding sites, as described in A6. These LDCs were developed under approved QAPP coverage.

Geospatial Data
The H-GAC Community & Environmental Planning Department's Data Management Plan, (Appendix A) outlines how both tabular (non-geographic) and spatial (geographic) datasets are captured, manipulated, analyzed, stored, and displayed within the Geospatial/Geographic Information Systems (GIS) environment as it relates to sharing of data, development of geospatial applications, cartography, and underlying GIS resources (see Appendix A for more detail). Existing geospatial data resources at H-GAC will be combined with additional data from appropriate local, regional, state, and federal organizations as needed. Geospatial data used for modeling exercise will be of acceptable quality based on the data quality objectives of this project, and will have been published with appropriate metadata. The publishing of geospatial data by various organizations implies that the data is of known quality, that is has been subject to review and approval by the publishing organization and has required metadata to prove its accuracy and completeness.

All outside data sources will be reviewed to determine level of quality, compatibility and completeness. Procedures used to collect these outside sources will also be reviewed to determine compatibility and determine level of sampling bias and uncertainty. Generally, data used from outside sources will be acceptable if it was collected under an existing QAPP, published in peer review literature or if sufficient and documented QA/QC procedures were employed during project data collection and analysis.

H-GAC utilizes ESRI's ArcGIS 10 platform for all geospatial analysis and mapping needs. The ESRI ArcGIS 10 platform includes integrated Python programming capabilities, which allows

[1] https://www.tceq.texas.gov/waterquality/tmdl/82-sanjacintobacteria

for the creation of programming scripts or batch programs to improve efficiency and documentation of processes. The Python programming language is an Open Source platform, and is freely distributable.

Derived GIS layer data from other QAPP-covered CRP assessments (e.g. potential sources of contamination in a watershed identified under a Basin Highlights Report or Basin Summary Report) may be utilized if it is of equal or greater adherence with the data quality objectives for this project.

Modeling Assumptions and Literature Values

The SELECT and LDC models rely on a mix of actual measurements and assumptions (whereas the GLAM tool relies on existing GIS data and literature values.) The application of the SWAT model to generate a simply hydrological runoff estimation relies on assumptions internal to the model, but its inputs are shared with the other modeling applications (e.g. HUC 10 boundaries, land cover, etc.) Some assumptions are integral to the models, while others are able to be modified or are based on local data/accounts. Literature values intended to be used for these modeling efforts include rate, volume and character of fecal deposition by various sources; event mean bacteria concentrations specific to land cover types; nutrient loading characteristics of land cover types; source population estimates (e.g. number of feral hogs/mile), and impacts of various best management practices. Selection of literature values will show preference to peer-reviewed scientific literature, most locality-specific references, and currency of reference, as modified by agency and stakeholder feedback.

Other Data

Data used for qualitative assessment, stakeholder discussion, and watershed characterization not related to modeling efforts covered under this QAPP may include Texas Stream Team volunteer monitoring data, outputs/results from the San Jacinto River Authority's WPP for Lake Conroe, spatial data generated by the Trust for Public Land as part of the West Fork San Jacinto River Watershed Greenprint project, and other local data as encountered during the course of the WPP development project. These data sources are not intended to be used directly for the modeling efforts covered under this QAPP, but may influence staff and stakeholder decisions regarding assumptions, etc.

Table B9.1 Acquired Data Sources

Type of Measurement or Analysis	Type of Data	Units	Source	Quality Assurance Documentation	Use	Date Range
Ambient water quality monitoring data	Periodic water quality	Various	SWQMIS	www.tceq.state.tx.us/ waterquality/ monitoring/swqm_guides.html	Used as observed values for modeling efforts	Various, depending on station
DMRs	Periodic water quality reporting	Various	TPDES permittees via TCEQ		Used to characterize WWTF loading	Various, depending on station
SSO violation	Episodic	Various	TPDES		Used to	Various,

Type of Measurement or Analysis	Type of Data	Units	Source	Quality Assurance Documentation	Use	Date Range
data	violation reporting		permittees via TCEQ		characterize collection system loading	depending on station
Regional demographic / land cover change	Modeled projections	Various	H-GAC		Used to characterize land cover and population change	2015-2040
OSSF locations	Spatial database	Individual OSSF records	H-GAC	Completed under H-GAC Regional Geospatial Data QAPP	Used to characterize OSSF loads	Various-2015
TMDL LDCs	Model outputs	Various	TCEQ	Completed under original TIAER/TCEQ Modeling QAPP for East and West Forks San Jacinto River TMDL project	Used to inform LDC development	Various
GIS layers	Geospatial datasets	Various	Various		Used to develop models and for cartographic purposes	Various
Literature values	Various	Various	Various		Used to develop models/tools	Various

B10 DATA MANAGEMENT AND HARDWARE/SOFTWARE CONFIGURATION

Data evaluated, acquired, produced or maintained under this QAPP will be handled in accordance with the Data Management Plan (attached as Appendix A.) H-GAC uses this data management plan for all related water quality efforts requiring QAPP coverage (e.g., CRP.)

B10 (a) Data Management

H-GAC data management procedures are discussed at length in Appendix A.

Data Dictionary

H-GAC standard data terminology and definitions are discussed at length in Appendix A.

Migration/Transfer/Conversion

H-GAC standard data terminology and definitions are discussed at length in Appendix A.

Information Dissemination
Project updates will be provided to the NPS Project Manager in progress reports and the information will be made available at stakeholder meetings. Input data and model outputs resulting from the project described in this QAPP will be accessible to the general public and the TCEQ after appropriate QA review. Additional procedures are discussed at length in Appendix A.

B10 (B) Hardware/Software configuration

Archives/Data Retention
Complete original data sets are archived on permanent media (tape drives) and retained on-site by the H-GAC for a retention period specified in Table A9.1 Project Documents and Records. Additional discussion of archiving procedure is indicated in Appendix A.

Backup/Disaster Recovery
All work and file storage takes place on a shared network drive(s) which are continuously backed up on the network servers and archived on a regular basis. In the event of a catastrophic systems failure, the archival backups can be used to restore the data in less than one day's time. Data generated on the day of the failure may be lost, but can be reproduced from raw data in most cases.

Systems Design
H-GAC uses laptop personal computers and desktop personal computers. The computers run Windows 7, 8 or 10 operating systems. Software includes Microsoft® Word, Microsoft® Excel, Microsoft® Access, and a Statistical Analysis System database management system run through the Windows operating system. All GIS analysis will be performed using the most current version of ArcGIS (currently 10X.X.) The SELECT modeling efforts will use proprietary software or additions thereto.

SECTION C: ASSESSMENT AND OVERSIGHT

C1 ASSESSMENTS AND RESPONSE ACTIONS

The following table presents types of assessments and response action for activities applicable to this QAPP.

Table C1.1 Assessments and Response Actions

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	H-GAC Project Manager, QAO, Data Manager, and Lead Modeler	Monitoring of the project status and records to ensure requirements are being fulfilled. Monitoring and review of project staff performance and data quality	Report to TCEQ in Quarterly/Monthly Report. Ensure project requirements are being fulfilled.
Technical Systems Audit	Dates to be determined by TCEQ	TCEQ QAS	The assessment will be tailored in accordance with objectives needed to assure compliance with the QAPP	30 days to respond in writing to the TCEQ to address corrective actions

Internal Assessment

Since this project is primarily a modeling endeavor, traditional performance and system audits are not appropriate. Instead, the data generated as part of the modeling results will be evaluated during the model output interpretation and stakeholder review processes. Modeling performance assessments will be made continually by H-GAC and the TCEQ NPS Program as described in the validation and calibration processes.
Modeling data and project deliverables will be internally quality controlled by the NPS Project Manager's in-house review. The Project Manager will maintain overall responsibility for examining the contracted work to ensure methodologies and processes are consistent with the procedures outlined in this QAPP.

Corrective Action

The H-GAC Project Manager is responsible for implementing and tracking corrective action procedures as a result of audit findings. Records of audit findings and corrective actions are maintained by the TCEQ Project Manager and H-GAC QAO. Corrective action documentation will be submitted to the TCEQ NPS Project Manager with the progress report.

If audit findings and corrective actions cannot be resolved, then the authority and responsibility for terminating work is specified in agreements or contracts between participating organizations.

The H-GAC Project Manager and/or the H-GAC QAO are responsible for documenting deficiencies and nonconformances and reporting these to their management. A CAR must be completed and submitted to the TCEQ with the next progress report due after the deficiency and/or nonconformance occurred.

C2 REPORTS TO MANAGEMENT

Reports to H-GAC Project Management
H-GAC project staff will report to the H-GAC PM on an ongoing basis, but at a frequency no less than once a week. These reports will be informal unless corrective action, relevant modeling notes, or other documentation as discussed in this QAPP apply.

Reports to TCEQ Project Management
Progress Report –Submittal of progress reports will occur quarterly as part of routine quarterly reporting requirements, although informal reporting or reporting generated by specific instance (corrective action, etc.) may occur more frequently as needed. Format of the submitted progress reports will be as specified in the contract or work orders. Reports should provide enough information so the TCEQ Project Manager can evaluate the modeling effort.

Interim Reports – In addition to quarterly reports and other formal and informal communication with TCEQ project staff, H-GAC PM will submit formal interim reports for:

- Draft Acquired Modeling Data Report – Quarter 4
- Final Acquired Modeling Data Report – Quarter 5
- Draft Data Collection and Trends Analysis Report – Quarter 7
- Final Data Collection and Trends Analysis Report – Quarter 8
- Modeling Method Description Analysis Report – Quarter 3
- Modeling Support Document (Interim) – Quarter 7
- Draft Modeling Report – Quarter 9
- Final Modeling Report – Quarter 9

Final Report – H-GAC will submit a final report for the entire project effort in draft form by Quarter 13, month 1 of the contract, and in final form by Quarter 13, Month 3 of the contract. Any comments from TCEQ will be summarized in a comment response document in the interim.

Corrective Action Report (CAR) – Identifies any deficiencies and nonconformances. The cause(s) and program impacts are discussed. The completed corrective actions are documented, and the report is submitted to the TCEQ Project Manager with the first progress report occurring after the deficiencies and/or nonconformance was identified.

Audit Report and Response - Following any audit performed by H-GAC, a report of findings, recommendations and responses are sent to the TCEQ project manager in the quarterly/monthly progress report. Such reports will include model performance assessments, calibration, and validation performance determination as appropriate.

Reports by TCEQ Project Management

Contractor Evaluation – H-GAC is evaluated in a Contractor Evaluation by the TCEQ annually for compliance with administrative and programmatic standards. Results of the evaluation are submitted to the TCEQ Financial Administration Division, Procurements and Contracts Section.

SECTION D: DATA VALIDATION AND USABILITY

Validation - Validation is an extension of the calibration process that reduces uncertainty. The rates and settings developed during calibration are checked for adequacy using data set(s) that represent the modeled water body under different conditions than were observed during the calibration data set. The rates then, if necessary, are adjusted further so that they can represent all data sets. Validation is the comparison of the modeled results with independently derived numerical observations from the simulated environment. Model validation is, in reality, an extension of the calibration process. Its purpose is to assure that the calibrated model properly assesses the range of variables and conditions that are expected within the simulation.

D1 DEPARTURES FROM VALIDATION CRITERIA

The water quality data analyses, SELECT, GLAM, and load duration curves are not calibrated models, and are not predictive of instream water quality conditions[1].
Departure from established criteria may impact the accuracy of model outputs. Sources of discrepancy may be insufficiency of available data and/or locally applicable assumptions. However, given the intended uses of the data (i.e. to facilitate stakeholder decision-making on a broad basis) these potential discrepancies are not expected to have an appreciable impact on model results.

D2 VALIDATION METHODS

Data collected by the TCEQ, the USGS, Texas CRP partners, and other listed sources have been verified and validated according to the requirements of the respective programs prior to their use in this project. Data compilations created for this project will be electronically and/or visually screened for errors. For more information on data management procedures see Appendix A.

Model Validation

The water quality data analyses are not subject to model validation. The SAS outputs are reviewed by H-GAC staff, as part of normal data management procedures.

LDCs are also not validated in a traditional sense, as they are not predictive models. The results of LDC runs are similarly validated by H-GAC staff, and through review with TCEQ project staff and stakeholders. Because LDCs are descriptive rather than predictive, no validation against additional data is possible.

The SELECT runs are predictive of potential load, but without linkage to observed data (i.e. they are not predictive of instream concentrations.) SELECT results are not calibrated to observed data because potential load is not a measureable/measured constituent. Non-technical validation

[1] Future scenarios projected under SELECT are based on regional demographic projections, but are only predictive of potential loads. They cannot be calibrated against observed values, as they do not predict ambient water quality conditions.

of SELECT inputs and outputs is primarily based on H-GAC, TCEQ, and stakeholder review of model assumptions and outputs. Criteria in these reviews include the applicability and sufficiency of assumptions and subjective comparison of model outputs with local conditions as experienced by stakeholders. This process is not intended as a technical validation.

The GLAM tool is used only to generate potential loads from nutrients based on existing land cover data. It does not take into account any linkage between instream quality and loads, or attempt to model watershed processes. It is a geospatial tool for summing contributions by land uses within subwatersheds. Non-technical validation of GLAM inputs and outputs is primarily based on H-GAC, TCEQ, and stakeholder review of tool assumptions and outputs. Criteria in these reviews include the applicability and sufficiency of assumptions and subjective comparison of model outputs with local conditions as experienced by stakeholders. This process is not intended as a technical validation.

D3 RECONCILIATION WITH USER REQUIREMENTS

The primary purposes of the data outputs from these analysis and modeling efforts are to characterize the conditions in the watershed and guide stakeholder decision-making. The user requirements for WPP development are to provide a high level understanding of the causes and sources of pollutants in spatial and flow contexts. The modeling framework developed for this project will be used to evaluate contaminant loading in the West Fork San Jacinto River watershed(s). It will provide information pertaining to historical trends in water quality, relationship of pollutant loads to flow regimes and bacteria reductions (LDCs), and potential loading from pollutant within the watershed (SELECT/GLAM). These four analyses will provide critical information for the stakeholders to support the development of the West Fork San Jacinto River WPP and characterize conditions in Spring and Cypress Creeks.

The user requirements do not assume a detailed and complex hydrologic model with predictive linkage between source loading and instream concentrations. Source load reduction projections sufficient to guide stakeholder decisions will be obtained by applying load reduction percentages generated through LDCs to source loads generated in SELECT/GLAM analyses.

The outputs will be evaluated at several levels. First, H-GAC project staff will review outputs for obvious inconsistencies and errors, for compliance with QAPP procedures, and against best professional judgment. Secondly, outputs will be reviewed with TCEQ project staff. Lastly, outputs will be reviewed with stakeholders and technical advisors to ensure local input is acquired and incorporated as appropriate. Additional review will follow revised model runs and scenarios. The final data will be reviewed to ensure that it meets the requirements as described in this QAPP. CARs will be initiated in cases where invalid or incorrect data have been detected. Data that have been reviewed, verified, and validated will be summarized for their ability to meet the data quality objectives of the project and the informational needs of water quality agency decision-makers. The sufficiency of the data to support stakeholder requirements will be based on review of the data with the stakeholders and agency staff.

Some limitations are assumed for the use of the model outputs. The usability of the modeling results will be limited to their intended purposes as part of an EPA 9-element WWP development

process (Lake Creek and West Fork San Jacinto River) or watershed characterization project (Spring and Cypress Creeks). The model results are not intended or designed to provide a level of accuracy or precision beyond what is described or the stated ability of the models. Model results are not intended to be used for legal purposes, to describe property conditions in lieu of environmental assessments, or to be used for other official purpose not stated in this QAPP. The design of the modeling approach is intended to allow the flexibility, as described, to incorporate stakeholder input on assumptions, outputs, and specific locales or events in the watershed. The limitations on the use of the data

APPENDIX A - DATA MANAGEMENT PLAN

Data Management Plan

July 2015

HOUSTON-GALVESTON AREA COUNCIL

Community & Environmental Planning Department

Prepared in cooperation with the

Texas Commission on Environmental Quality

under the authorization of the Texas Clean Rivers Act

Table of Contents

Introduction

The Data Management Plan (The Plan) outlines the standard policies and procedures for data management within the Community and Environmental Planning (C&E) Department. The Plan covers the management of both tabular (non-geographic) and spatial (geographic) datasets. Its primary purpose is to ensure the efficient access and maintenance of these datasets within the C&E Geospatial/Geographic Information Systems (GIS) environment.

GIS technology provides a systematic means to capture, manipulate, analyze, store and display spatially referenced data. GIS supports a wide variety of applications ranging from site assessments, environmental planning, urban planning, and spatial analysis to support organizational strategies. In general, GIS supports the overall departmental goals of guiding regional planning, enhancing the quality of the region's natural environment, and public education through outreach programs. The C&E GIS team supports various programs within the C&E department through data development, spatial analysis, geospatial applications development, cartography in support of departmental goals.

The Plan is considered a dynamic working document which responds to changing technology, funding, staffing, and project requirements. Consequently, the Plan is reviewed on an annual basis and amended as necessary.

Geospatial Services

The following section explains the geospatial services provided by the H-GAC C&E GIS team as it relates to the sharing of data, development of geospatial applications, cartography, and underlying GIS resources. The C&E GIS team is responsible for the development of data and sharing of many publicly viable datasets, developing geospatial applications, cartography, and coordination of maintenance of underlying geospatial hardware and software for C&E.

The C&E GIS team maintains a centralized geospatial warehouse (C&E SDE), an online mapping platform for web-based geospatial applications (Mapping Server), and an FTP download site (Data Clearinghouse). The C&E SDE utilizes ESRI's ArcSDE software running on a Microsoft SQLServer RDBMS. The mapping server uses ESRI's ArcGIS Server platform running on .NET. The Data Clearinghouse is an FTP server that provides C&E with storage space where it can post publicly available datasets for downloading. The C&E SDE, Mapping Server, and Data Clearinghouse platforms are installed by the H-GAC Data Services department (Data Services), with Data Services maintaining only the lower-level technology components such as the physical hardware, software installation, and low-level server and RDBMS functions. All upgrades and maintenance is coordinated by the C&E GIS Manager. All geospatial content stored in the C&E SDE, the Data Clearinghouse, and Mapping Server, are the responsibility of the C&E GIS staff, which resides within the C&E Socio-Economic Modeling program. A detailed schematic of the geospatial technical architecture and how the various systems are interconnected can be found in the *System Architecture* section below.

Data Sharing

The C&E SDE serves as the primary internal repository for geospatial data, metadata, and other information relevant to the activities and goals of the C&E department. All GIS users within C&E and some users from other H-GAC departments are provided *Editor* or *Viewer* access to data in the C&E SDE. The majority of users outside the core C&E GIS team have only viewer access to data in the C&E SDE. Other specific users that maintain data in the C&E SDE have editor access to the datasets. All user access privileges are assigned by the C&E GIS Manager based upon business needs, GIS skills, and role within the organization. No users outside of the C&E department have editor level access to any GIS data in the C&E SDE, and in some instances there are datasets that are viewable by only C&E GIS users. Instructions for connecting to the C&E SDE are provided to authorized users.

Datasets determined to be viable for publication to the public are exported to the Data Clearinghouse website, thereby allowing the general public widespread access to this information via the internet. Members of the public may view metadata and download any of the datasets that are posted to the Data Clearinghouse. In some instances these datasets are used in web-based mapping applications and can be accessed online via the Mapping Server's services directory, or accessible via the Data Clearinghouse for downloading. All public C&E GIS data, applications, cartographic products, and the C&E map services directory can be accessed via our C&E GIS page at http://www.h-gac.com/go/cegis, and a screen shot of the website can be found in Appendix 7.

Geospatial Applications

The C&E department has made a strategic decision to incorporate internet-based mapping applications into its deliverables for many programs and projects. Before, the results of most projects consisted of a large-format map printed on a plotter up to 48"x36" in diameter. This form of cartography although still useful in many settings, did not allow programs to communicate results to the public or external organizations that had an interest in our analysis results. By taking results from C&E projects and coupling this with base map data and imagery, C&E has been able to share the results of projects to a far greater audience, and has create opportunities whereby map layers published on the C&E mapping server can be utilized in other organizations mapping applications.

Currently there are three platforms upon which C&E provides internet-based mapping solutions. The first platform is based on the Adobe Flex programming environment, and all mapping applications developed using this platform run inside standard internet browsers that support the Flash technology, such as Internet Explorer. This platform is intended to provide users with a graphics rich user interface whereby the map can be navigated, layers turned on/off, and information obtained on each feature. In some instances, features have links to additional resources such as photos of monitoring stations, external websites, and detailed reports. This mapping application environment allows the users to make full use of their computers internet browser window, and serves as a simple online GIS.

The second platform utilizes the capabilities of the ArcServer platform to allow users to directly access map layers published on the mapping server. This method of delivery is called 'streaming' and allows end users read-only access to individual map layers ad geoprocessing tools published on the server. Typical users of this method of deliver are other GIS users using desktop GIS, whereby they can connect directly to our ArcServer platform for read-only access and view our map layers. Other instances whereby users may utilize this method is where they are including our map layers in their own mapping applications.

The third and final platform involves developing applications for mobile devices or tablets. The C&E department has developed both native (installed) applications for the Apple iOS platform, as well as server-side scripted applications which utilize the free ESRI ArcGIS for Mobile Devices viewer app, which runs on iOS, Android, or Windows phone devices. In both instances, map layers used in these applications are delivered from the C&E ArcServer platform.

As previously mentioned, access to all the above forms of applications and data sharing methods can be accessed via our C&E GIS page at http://www.h-gac.com/go/cegis.

Mapping and Cartographic Products

The C&E department produces a variety of static cartographic maps for the region as a result of project activities and for general usage. To facilitate the sharing of these maps in an electronic format, C&E has implemented a Map Book as part of their C&E GIS page. Maps can be downloaded in multiple formats. The C&E Map Book can be accessed via our C&E GIS page at http://www.h-gac.com/go/cegis.

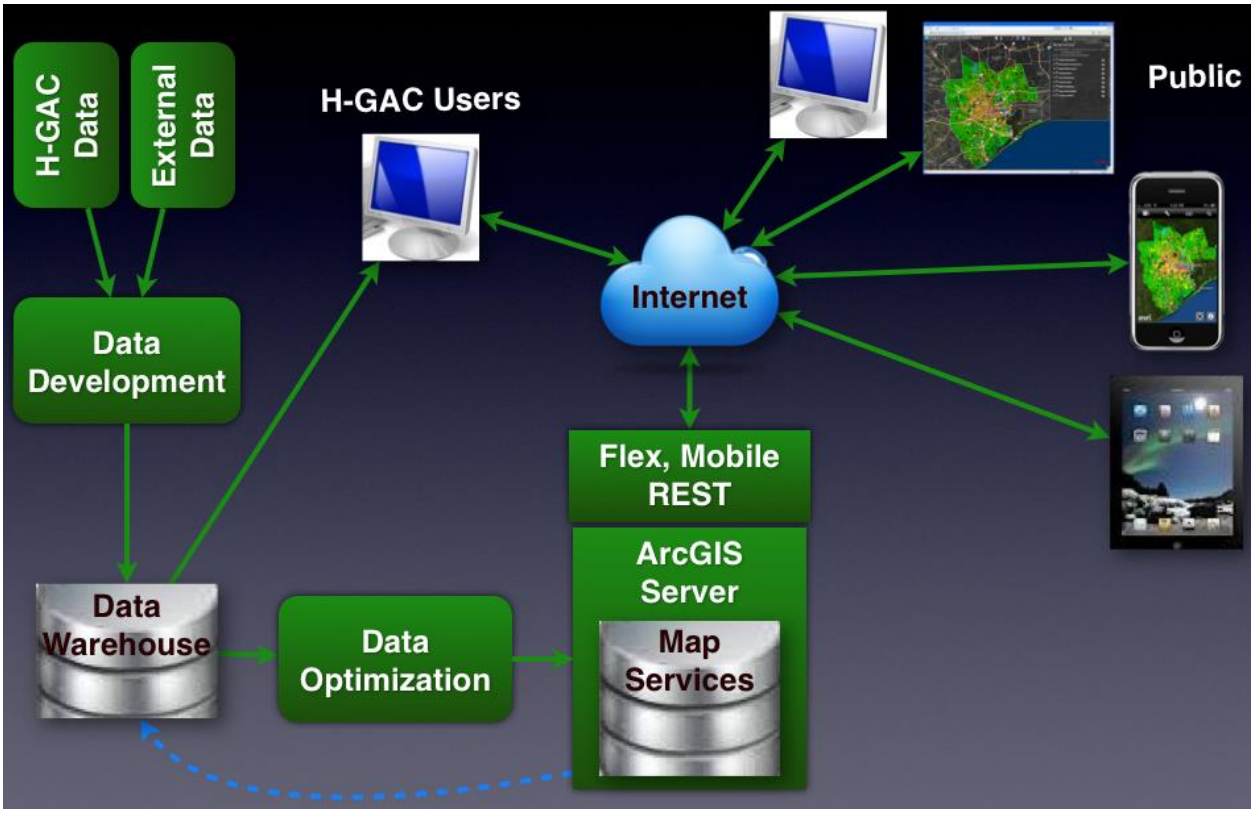
System Resources

System Architecture

The C&E department uses an integrated architecture to support the development, analysis, and dissemination of spatial information. The diagram below illustrates this system architecture at a high level. The goal of the overall system is to allow for a streamlined workflow to develop/maintain data, optimize the data for use in online applications, and the consumption of applications via multiple platforms.

Currently the C&E GIS platform supports sharing of geospatial data via the ArcServer mapping server platform. This allows end users internally or externally to consume map layers and geoprocessing tools via GIS desktop, mobile, tablet, or 3rd part applications.

In some instances, applications are configured with public feedback and volunteer GIS workflows that allow the C&E GIS team to obtain information for the public on various geographic features in the region. This public feedback loop allows C&E to investigate feedback and verify its validity prior to incorporating the information into the data warehouse.



Hardware

The configuration of the hardware used by staff that performs GIS and data Management work is a distributed network" This network consists of several PC's which are connected to central file servers. The department also uses a central web mapping server for online mapping applications.

A complete listing of departmental hardware is found in Appendix 3.

Software

The C&E department relies upon the H-GAC Data Services department (Data Services) for all of its end user workstation configuration, installation, and maintenance. Each workstation for users comes with the Microsoft Office software package which includes Outlook (e-mail), Word (word processing), Excel (spreadsheets), PowerPoint (presentations), and in some instances Access (desktop database) should the user require desktop database capabilities. Each workstation is pre-configured and setup to operate within the H-GAC internal network, and has access to central servers for file storage. In some instances, certain personnel have addition non-standard software installed by Data Services as it is required for their responsibilities.

The C&E GIS staff utilizes ESRI's ArcGIS 10.1 platform for all geospatial analysis and mapping needs. In addition, as needed, the staff also utilizes the SAS software platform for further analysis and data development as deemed necessary. The ESRI ArcGIS 10.1 platform includes integrated Python programming capabilities, which allows for the creation of programming

scripts or batch programs to improve efficiency and documentation of processes. The Python programming language is an Open Source platform, and is freely distributable.

The centralized SDE is also provided by ESRI, and provided for a centralized geospatial database where GIS staff can store geospatial data for either read-only or editable access by GIS users in the C&E department. The C&E GIS staff maintains access privileges to the SDE datasets, and assigns individual users to various SDE access groups to grant approved accessed to data in the SDE. The SDE is considered the central warehouse whereby GIS users can go to for geospatial data to use in their analysis or mapping projects.

The software products currently used to accomplish the department's data management objectives are listed in Appendix 4.

Programming Languages

Programming services will be provided on an as needed and resource available basis. All programming efforts will follow a standard procedure from needs assessment, program planning, development and testing, to refinement and documentation. The principal programming languages to be used in task automation and project customization will depend on the nature of the need and the current state of the technology. At this time, all web-based GIS applications are developed using the ESRI ArcGIS Server platform, and user interface components to that platform are developed using the Adobe Flex API. Automated data development and analysis workflows utilize the Python programming language and the SAS programming platform as needed.

Data

Department staff members will be consulted annually to determine priority needs for data management. Based on this consultation, specific data sets will be acquired or further developed for the various program areas represented in the department. The current list of department-specific data sets is shown in Appendix 5.

A separate database lists all datasets regularly obtained from external sources, contact information, as well as the frequency of the datasets availability, and its cost. This database is developed using Microsoft Access, and is available to the C&E GIS team for tracking when updates to dataset may be available.

Personnel

The Data Management staff will be responsible for the maintenance and development of the C&E SDE, mapping server, geospatial applications, C&E GIS page, and Data Clearinghouse. These data management responsibilities cover a wide range from original data creation, acquisition and integration, data archiving and distribution. Additional responsibilities include enhancing the geographic extent, feature attributes, and metadata of the datasets.

The C&E GIS team is comprised of 3 full-time GIS professionals, one of which is the GIS Manager, and 2 full-time GIS Analysts. The C&E GIS team supports all programs within the C&E department, which include Clean Rivers/Water Quality, Sustainability, Economic Development, Solid Waste, Ped/Bike, Socio-Economic Modeling, and special project. The C&E GIS team is part of the Socio-Economic Modeling program within C&E.

H-GAC's Data Services Department plays an indirect role in the implementation and maintenance of The Plan. The Data Services Department is responsible for managing the underlying hardware and network upon which C&E stores GIS data and implements GIS-based applications.

Training

Training for all users of the system is a critical part of The Plan. C&E staff directly responsible for data management will attend conferences, seminars, and software/hardware training courses as needed. H-GAC users of the system will be trained and/or receive technical support by the C&E GIS Manger and other C&E subject matter experts.

Budget

Budgetary requirements to sustain data management efforts will be reviewed annually.

Data Maintenance, Manipulation, and Use

Quality Assurance/Quality Control

QA/QC is designed to standardize screening, documentation, entry, output, analysis, correction, and updating of data in the system. QA/QC will document those responsible for data and system maintenance.

Data Limitations

Prior to the integration of data within the C&E SDE and posting to the Data Clearinghouse, a review of the data set will be completed to determine predefined data limitations such as missing values, different sampling frequencies, multiple measurements, analytical uncertainty, censored or unavailable data, and duplicated data with existing data sets. After review of the data set, a report will be generated which records any errors detected and any corrections that may be necessary.

Data Development Protocol

The C&E GIS staff works to update existing dataset, acquire new data, and perform geospatial analysis in support of various C&E programs. All new data generated from the result of an analysis is a candidate to be stored not only in the SDE as a new dataset, but also as a layer with a mapping application should the need arise. All data development and analysis is done internally to C&E, and at times leverages outside resources such as consultants, other non-profits whom H-GAC is partnering with, as well as with other H-GAC departments to obtain necessary data. Two datasets that the C&E department uses regularly outside the C&E SDE are the Data Services StarMap road centerline dataset, and the Data Services aerial imagery database.

The C&E GIS staff uses a hybrid approach to conducting geospatial analysis. Much of the analysis being performed may need to be re-processed at a later date as new versions of datasets become available, or as inputs to the analysis models are updated themselves. Thus to minimize the time spend re-running analysis models, the C&E GIS staff utilizes the ESRI ArcGIS platform in conjunction with SAS and Python to develop repeatable and documented workflows. This approach saves more time than interactive methods whereby a user must remember the process to follow, and then execute each step in the analysis independently.

Documentation related to data management efforts such as system evolution, structure, and procedures for use will be compiled and made available for the end user. Documentation will be made available online and in hard copy format.

<u>Data Input</u>

Standard conventions for data input will be determined on a per-project and/or individual data set basis. To ensure Year 2000 Compliance, all data sets with date/time fields will include a four-digit year (YYYY). Either of the following formats will be used: International Standard Date

notation where the date field is represented as MM/DD/YYYY (Month/Day/Year), or an ordinal format where the date field is represented as YYYYDDD.

Data Dictionary and Metadata

A list of all C&E data available in either the C&E SDE or other tabular formats can be found in Appendix 5. Metadata for each dataset in the C&E SDE is stored with the datasets, and can be viewed by GIS users via their GIS desktop software. Any data provided for public download via the Data Clearinghouse also has a metadata html page that can be viewed via internet browsers.

Data Conversion

Data to be imported into the C&E SDE from hard copy, digital or by manual data entry, will follow a uniform conversion protocol to comply with the structure of current data sets. The type of data being converted will determine the protocol. All data is stored in ESRI geodatabase format within the C&E SDE, and when posted to the Data Clearinghouse the data is stored in the ESRI File Geodatabase file format, unless there is a specific requirement to provide the data in another format such as Shapefile or GIS Coverage.

Coordinate Systems

The Texas Stateplane Coordinate System, North American Datum 1983 (NAD83) will be the standard for geographic data at H-GAC. This coordinate system is based on the Cartesian coordinate system, or rectangular coordinates. When receiving geographic data from other sources the data will be transformed into the Stateplane Coordinate System to ensure compatibility with current data sets.

When publishing mapping services for use in web-based GIS mapping applications, the Web Mercator Auxiliary Sphere projection is used for all Data Frame projections. However, the underlying GIS data within these mapping services still use the Texas Stateplane Coordinate System, North American Datum 1983 (NAD83) projection.

Data Validation

Data Quality Control

When data are received from any source, documentation will be created to include the source name, date received, format of data and a brief description of the contents. Data will be loaded onto the system from the media received and a review of the data will be made along with any corrections being made to the source documentation. An analysis will be made in order to determine the means of data entry into the system whether it is only a stand-alone database, a number of linked tables, or a geographic database. The data will be converted to the appropriate format for integration with the current system whether it is a conversion into MS Access, Excel, SAS, or ESRI ArcGIS. The data will be visually examined to determine its validity and accuracy. If the data is invalid it will be corrected (if possible) otherwise the data will be incorporated into the C&E SDE, and then if applicable, posted to the Data Clearinghouse and used in conjunction with existing data. A QA/QC report of all procedures and a detailed description of how the data

was incorporated into the current system (from the date received to the date of integration) will be generated.

Equipment Quality Control
All printers, workstations, and server hardware and operating systems are maintained by the Data Services department, unless otherwise noted in Appendix 3.

Genealogy
Upon receipt of data from outside sources, all data will be screened for integrity and completeness. After the preliminary evaluation of the data, a log of the data source, type and completeness is created and maintained with the associated data. A description of the data and the responsible personnel are documented.

Migration/Transfer
A copy of every C&E generated GIS dataset will be housed in the C&E SDE which C&E GIS staff manages the contents and structure of datasets. The underlying hardware and network connections for the C&E SDE are maintained by the Data Services Department. Datasets that are of public interest will be placed in the Data Clearinghouse for public access. Transfer from the C&E SDE to the Data Clearinghouse will occur on an as needed basis following department QA/QC measures and is handled by the C&E GIS team.

Data Security & Access
Data placed on the Data Clearinghouse will be available to those with Internet browsing and/or FTP capability. Data requests for non-public data from other agencies and the general public will be evaluated on an individual basis. When the data requests are received, a preliminary evaluation of the deliverable will be determined and a timeline and cost if applicable will be provided to the requesting agency or individual.

GIS and tabular data will be secure through directory permissions. H-GAC will employ Firewall or Proxy Server Technology to filter and severely restrict access to internal networks and database systems. Virus protection will be implemented to ensure system and data integrity.

Archives/Backup
Each week the C&E GIS team runs a schedule backup program to store a copy of all C&E SDE datasets on a portable hard drive with resides in a secure location within the H-GAC office. In addition, Data Services backs up and archives C&E SDE data and server configuration at regular intervals. A backup will be performed daily and the tapes will be maintained for 8 weeks before they will be recycled. Every six month, a complete system backup will be performed and the tapes will be archived and kept for five years off-site for security.

Disaster Recovery
In the event of a disaster, the C&E department will have access to all C&E SDE data which is stored on the portable hard drive. The C&E GIS team will restore or provide needed data to GIS users from this portable hard drive until such as time that Data Services can restore the C&E

SDE onto either a new server or a temporary server.

Appendices

Appendix 1 Data Source Information Sheet

Data Title:

Source Agency:
Contact:
Title:
Address
Phone:

Data Description:
Data source:
Date created:
Accuracy:
Media:
Data items:

Description of data:

Format (specify what software)
Map:
Tabular:
Image:
Text:

Retrieval Procedure:

Command(s):

Appendix 2 Data Log Sheet

Date received: _____

Report Prepared by: _____

Source Name and Phone: _____

Format: _____

Media: _____

Check the following steps to determine the validity of the data:

1. What is the extent of the geographic area? _____
_____

2. Structure (Circle One) Vector Raster

3. Scale? _____

4. Projection and Datum? _____

1. Do any of the key fields have missing values? If so which parameters have missing values? Yes ___ No ___
_____
_____
_____

2. Any known duplicate records? Yes ___ No ___

Appendix 3 Hardware

FTP Server
Windows 2000 Server

Mapping Application Servers

Production Server (NTCEIS01)

Model:	HP Proliant BL460c G6 Blade
CPU:	Quad-Core Intel Xeon X5560 (2.80 GHz, 8M Cache)
Memory:	8GB
Hard Drive:	300GB
OS:	Windows 2008
Internet Address:	204.65.99.189
Domain URL:	http://arcgis02.h-gac.com
Serial #:	USE936RV4S
Purchased:	January 2010

Development/Backup Server (NTIS04)

Model:	HP Proliant DL 380 G3
CPU:	Single Intel Xeon 2800
Memory:	1GB
Hard Drive:	C = 16 GB, D=66 GB
OS:	Windows 2000 SP 4
Internet Address:	204.65.99.240
Domain URL:	http://arcgis.h-gac.com
Serial #:	D313LDN1L122
Purchased:	April 2003

Printers & Plotters
HP1055CM Plotter - Used by C&E staff for large format printing of maps and schematics.

HP2500CM and LaserJet 4M Printers. C&E maintains both printers.

Global Positioning System (GPS) Units
The C&E Department possesses two GPS units.

Scanning Equipment
HP Scanjet 7400c. The CEP Department owns one network-accessible HP scanner.

Fax Equipment
Brother Intellifax 4750e. The C&E Department owns one fax machine.

Portable Storage Devices
Lacie 300GB external hard drive (USB, Firewire)

Appendix 4 Software

Office Productivity Software

Microsoft Office Pro (2007) - Word, Excel, Access, PowerPoint, publisher, InfoPath and Outlook.
Internet Explorer (ver. 7) – Primary Development Tool

Graphics and Desktop Publishing

Macromedia Fireworks 4
Adobe Illustrator (ver. 8.01) – Graphics
Adobe Photoshop (ver. 5.0) – Graphics
Corel Draw (ver. 7.0) - Graphics
Quark Express (ver. 5.0) - Desktop Publishing.
Paintshop Pro (ver. 4.12)
Camtasia Studio (ver. 7.0) – Screen capture and video tutorial production

Programming

Visual Basic (ver. 6.0) – Web Mapping Development Tool.
MS Active Server Pages (ver. 2.0) – Web Database Development Tool.
Adobe Flex Builder (ver. 4.0) – Web-based GIS application development tool
SAS (ver. 9.3) – Data development and analytics.

Geographic Information Systems (GIS)

ESRI ArcGIS (ver. 10.1, SP1) – Computer mapping and database manipulation capable of using ArcView, ArcInfo, and ArcEditor licenses as needed.
ESRI ArcGIS Server (ver. 10, SP3) – Internet Mapping Application Server.
ESRI ArcSDE (ver. 10.1, SP1) – Spatial data warehouse.

Data Management

Access (2007, 2010) - Relational Database.
SQL Server (2000) - Relational Database.

Operating Systems

Windows XP - PC working environment/Operating System
Windows 7 - PC working environment/Operating System
Windows 2003 & 2008 - Server Operating Systems

Appendix 5 Data List

C&E Spatial Data Warehouse (SDE) Datasets

Dataset Name	Type
AustCAD_Parcels_Coverage_2005	Polygon
AustCAD_Parcels_Coverage_2005_pts	Point
AustCAD_Parcels_Coverage_2006	Polygon
AustCAD_Parcels_Coverage_2006_pts	Point
AustCAD_Parcels_Coverage_2007	Polygon
AustCAD_Parcels_Coverage_2007_pts	Point
AustCAD_Parcels_Coverage_2008	Polygon
AustCAD_Parcels_Coverage_2008_Pts	Point
Austin_County	Polygon
AUSTIN_COUNTY_PARCEL_INFO_2005	Table
AUSTIN_COUNTY_PARCEL_INFO_2006	Table
AUSTIN_COUNTY_PARCEL_INFO_2007	Table
Austin_County_Parcel_Info_2008	Table
Austin_County_Parcel_Values_2006	Table
Austin_County_Parcel_Values_2007	Table
Austin_County_Parcel_Values_2008	Table
BrazCAD_Parcels_Coverage_2005	Polygon
BrazCAD_Parcels_Coverage_2005_pts	Point
BrazCAD_Parcels_Coverage_2006	Polygon
BrazCAD_Parcels_Coverage_2006_pts	Point
BrazCAD_Parcels_Coverage_2007	Polygon
BrazCAD_Parcels_Coverage_2007_pts	Point
BrazCAD_Parcels_Coverage_2008	Polygon
BrazCAD_Parcels_Coverage_2008_Pts	Point
Brazoria_County	Polygon
BRAZORIA_COUNTY_PARCEL_INFO_2005	Table
BRAZORIA_COUNTY_PARCEL_INFO_2006	Table
BRAZORIA_COUNTY_PARCEL_INFO_2007	Table
Brazoria_County_Parcel_Info_2008	Table
Brazoria_County_Parcel_Values_2005	Table
Brazoria_County_Parcel_Values_2006	Table
Brazoria_County_Parcel_Values_2007	Table
Brazoria_County_Parcel_Values_2008	Table
Brazoria_County_Political	Polygon
Chambers_County	Polygon
Chambers_County_Political	Polygon
Clean_Rivers_Public_Feedback	Point
Clean_Rivers_Public_Feedback__ATTACH	Table
Colorado_County	Polygon

CRP_Project_Areas	Polygon
FBendCAD_Parcels_Coverage_2005	Polygon
Dataset Name	**Type**
FBendCAD_Parcels_Coverage_2005_pts	Point
FBendCAD_Parcels_Coverage_2006	Polygon
FBendCAD_Parcels_Coverage_2006_pts	Point
FBendCAD_Parcels_Coverage_2007	Polygon
FBendCAD_Parcels_Coverage_2007_pts	Point
FBendCAD_Parcels_Coverage_2008	Polygon
FBendCAD_Parcels_Coverage_2008_Pts	Point
Fort_Bend_County	Polygon
Fort_Bend_County_Parcel_Info_2006	Table
Fort_Bend_County_Parcel_Info_2007	Table
Fort_Bend_County_Parcel_Info_2008	Table
Fort_Bend_County_Parcel_Values_2006	Table
Fort_Bend_County_Parcel_Values_2007	Table
Fort_Bend_County_Parcel_Values_2008	Table
GalvCAD_Parcels_Coverage_2005	Polygon
GalvCAD_Parcels_Coverage_2005_pts	Point
GalvCAD_Parcels_Coverage_2006	Polygon
GalvCAD_Parcels_Coverage_2006_pts	Point
GalvCAD_Parcels_Coverage_2007	Polygon
GalvCAD_Parcels_Coverage_2007_Pts	Point
GalvCAD_Parcels_Coverage_2008	Polygon
GalvCAD_Parcels_Coverage_2008_Pts	Point
Galveston_Bay_Estuary_Program_Watersheds	Polygon
Galveston_County	Polygon
GALVESTON_COUNTY_PARCEL_INFO_2005	Table
GALVESTON_COUNTY_PARCEL_INFO_2007	Table
Galveston_County_Parcel_Info_2008	Table
Galveston_County_Parcel_Values_2005	Table
Galveston_County_Parcel_Values_2007	Table
Galveston_County_Parcel_Values_2008	Table
Galveston_County_Political	Polygon
Grimes_County	Polygon
Gulf_Of_Mexico	Polygon
Harris_County	Polygon
Harris_County_FCD_Sub_Watersheds	Polygon
Harris_County_FCD_Watersheds	Polygon
HARRIS_COUNTY_PARCEL_INFO_2005	Table
HARRIS_COUNTY_PARCEL_INFO_2006	Table
HARRIS_COUNTY_PARCEL_INFO_2007	Table
Harris_County_Parcel_Info_2008	Table
Harris_County_Parcel_Values_2005	Table
Harris_County_Parcel_Values_2006	Table

Harris_County_Parcel_Values_2007	Table
Harris_County_Parcel_Values_2008	Table
Dataset Name	**Type**
Harris_County_Zones_58	Polygon
HCAD_Parcels_Coverage_2000	Polygon
HCAD_Parcels_Coverage_2000_pts	Point
HCAD_Parcels_Coverage_2003	Polygon
HCAD_Parcels_Coverage_2003_pts	Point
HCAD_Parcels_Coverage_2005	Polygon
HCAD_Parcels_Coverage_2005_pts	Point
HCAD_Parcels_Coverage_2006	Polygon
HCAD_Parcels_Coverage_2006_pts	Point
HCAD_Parcels_Coverage_2007	Polygon
HCAD_Parcels_Coverage_2007_Pts	Point
HCAD_Parcels_Coverage_2008	Polygon
HCAD_Parcels_Coverage_2008_Pts	Point
HGAC_13_County_Airports	Point
HGAC_13_County_Airports_ParcelIDs	Table
HGAC_13_County_BlockGroups_1990	Polygon
HGAC_13_County_BlockGroups_2000	Polygon
HGAC_13_County_BlockGroups_2010	Polygon
HGAC_13_County_Blocks_2000	Polygon
HGAC_13_County_Blocks_2010	Polygon
HGAC_13_County_Brownfield_Sites	Point
HGAC_13_County_Bus_Routes	Polyline
HGAC_13_County_Bus_Stops	Point
HGAC_13_County_Census_PL_Data_2010_Block_Groups	Table
HGAC_13_County_Census_PL_Data_2010_Blocks	Table
HGAC_13_County_Census_PL_Data_2010_Counties	Table
HGAC_13_County_Census_PL_Data_2010_Places	Table
HGAC_13_County_Census_PL_Data_2010_School_Districts	Table
HGAC_13_County_Census_PL_Data_2010_Tracts	Table
HGAC_13_County_Census_Places_2000	Polygon
HGAC_13_County_Census_Places_2000_Clipped	Polygon
HGAC_13_County_Census_Places_2000_Pts	Point
HGAC_13_County_Census_Places_2010	Polygon
HGAC_13_County_Census_Places_2010_Clipped	Polygon
HGAC_13_County_Census_Places_2010_Pts	Point
HGAC_13_County_Census_Urban_Areas_1990	Polygon
HGAC_13_County_Census_Urban_Areas_2000	Polygon
HGAC_13_County_Census_Urban_Areas_2009	Polygon
HGAC_13_County_Census_Urban_Areas_2010	Polygon
HGAC_13_County_Census_Zip_Codes_2010	Polygon
HGAC_13_County_City_Boundaries	Polygon
HGAC_13_County_City_Boundaries_Clipped	Polygon

HGAC_13_County_City_Ordinance_Areas	Polygon
HGAC_13_County_Closed_Landfill_Inventory	Point
Dataset Name	**Type**
HGAC_13_County_Landfill_Areas	Polygon
HGAC_13_County_Landfill_Areas_Historical	Polygon
HGAC_13_County_Landfills	Point
HGAC_13_County_Landfills_Historical	Point
HGAC_13_COUNTY_COASTAL_VIGNETTE	Raster
HGAC_13_County_Coastline	Polygon
HGAC_13_County_Coastline_Boundary	Polygon
HGAC_13_County_CRP_DO_Stations	Point
HGAC_13_County_CRP_Monitoring_Stations_2008	Point
HGAC_13_County_CRP_Monitoring_Stations_2010	Point
HGAC_13_County_CRP_Monitoring_Stations_2011	Point
HGAC_13_County_CRP_Monitoring_Stations_2012	Point
HGAC_13_County_CRP_Monitoring_Stations_2013	Point
HGAC_13_County_CRP_Monitoring_Stations_2014	Point
HGAC_13_County_CRP_Monitoring_Stations_2015	Point
HGAC_13_County_CRP_Monitoring_Stations_2016	Point
HGAC_13_County_CRP_Monitoring_Stations_Historical	Point
HGAC_13_County_Dams	Point
HGAC_13_County_Districts	Polygon
HGAC_13_County_Election_Precincts_2010	Polygon
HGAC_13_County_Farmland	Polygon
HGAC_13_County_Federal_Aid_Roads	Polyline
HGAC_13_County_G1M	Polygon
HGAC_13_County_G3M	Polygon
HGAC_13_County_G5M	Polygon
HGAC_13_County_Grocery_Stores	Point
HGAC_13_County_Libraries	Point
HGAC_13_County_Libraries_Parcel_Xref	Table
HGAC_13_County_Major_Rivers	Polyline
HGAC_13_County_Major_Roads	Polyline
HGAC_13_County_Metropolitan_Statistical_Area	Polygon
HGAC_13_County_OSSF_Permits	Point
HGAC_13_County_Parks	Point
HGAC_13_County_Parks_Awards	Table
HGAC_13_County_Parks_Features	Table
HGAC_13_County_Parks_Parcels	Table
HGAC_13_County_Pipelines	Polyline
HGAC_13_County_Plats	Polygon
HGAC_13_County_Political	Polygon
HGAC_13_County_Political_Boundary	Polygon
HGAC_13_County_Railroads	Polyline
HGAC_13_County_Raster_Extent	Polygon

HGAC_13_County_Recycle_Centers	Point
HGAC_13_County_School_Districts_Census_2010	Polygon
Dataset Name	**Type**
HGAC_13_County_School_Districts_TEA_2010	Polygon
HGAC_13_County_Service_Area_Boundaries	Polygon
HGAC_13_County_Soils	Polygon
HGAC_13_County_State_Parks	Polygon
HGAC_13_County_Superfund_NPL_Sites	Polygon
HGAC_13_County_Superfund_NPL_Sites_Pts	Point
HGAC_13_County_TIRZs	Polygon
HGAC_13_County_Tracts_1990	Polygon
HGAC_13_County_Tracts_2000	Polygon
HGAC_13_County_Tracts_2010	Polygon
HGAC_13_County_Transit_Centers_Parks_and_Rides	Point
HGAC_13_County_Water	Polygon
HGAC_13_County_Water_Detailed	Polygon
HGAC_13_County_Watershed_Project_Monitoring_Sites	Point
HGAC_13_County_Zip_Codes_2000	Polygon
HGAC_13_County_Zip_Codes_2002	Polygon
HGAC_13_County_Zip_Codes_2005	Polygon
HGAC_15_County_Aquifer_Recharge_Zones	Polygon
HGAC_15_County_Basins	Polygon
HGAC_15_County_Bio_Monitoring_Sites	Point
HGAC_15_County_Census_Zip_Codes_2010	Polygon
HGAC_15_County_City_Boundaries	Polygon
HGAC_15_County_City_Boundaries_Clipped	Polygon
HGAC_15_County_Coastline	Polygon
HGAC_15_County_Coastline_Boundary	Polygon
HGAC_15_County_Contours_2_Feet	Polyline
HGAC_15_County_Contours_5_Feet	Polyline
HGAC_15_COUNTY_CRP_Impairments	Table
HGAC_15_County_CRP_Lakes	Polygon
HGAC_15_County_CRP_Stream_End_Points	Point
HGAC_15_County_CRP_Streams	Polyline
HGAC_15_County_DEM_10m	Raster
HGAC_15_County_Hillshade	Raster
HGAC_15_County_Major_Rivers	Polyline
HGAC_15_County_Major_Roads	Polyline
HGAC_15_County_Political	Polygon
HGAC_15_County_Political_Boundary	Polygon
HGAC_15_County_School_Districts_TEA_2010	Polygon
HGAC_15_County_Soils	Polygon
HGAC_15_County_Wastewater_Outfalls	Point
HGAC_15_County_Wastewater_Outfalls_Historical	Point
HGAC_15_County_Wastewater_Outfalls_Info	Table

HGAC_15_County_Water	Polygon
HGAC_15_County_Watershed_Insets	Polygon
Dataset Name	**Type**
HGAC_15_County_Watershed_Signs	Point
HGAC_15_County_Watersheds	Polygon
HGAC_15_County_Zip_Codes_2000	Polygon
HGAC_15_County_Zip_Codes_2002	Polygon
HGAC_8_County_Bikeway_Needs	Polyline
HGAC_8_County_Bikeways	Polyline
HGAC_8_County_BlockGroups_2000	Polygon
HGAC_8_County_BlockGroups_2010	Polygon
HGAC_8_County_Blocks_2000	Polygon
HGAC_8_County_Blocks_2010	Polygon
HGAC_8_County_Census_Places_2000	Polygon
HGAC_8_County_Census_Places_2000_Clipped	Polygon
HGAC_8_County_Census_Places_2000_Pts	Polygon
HGAC_8_County_Census_Places_2010	Polygon
HGAC_8_County_Census_Places_2010_Clipped	Polygon
HGAC_8_County_Census_Places_2010_Pts	Polygon
HGAC_8_County_Census_Urban_Areas_2000	Polygon
HGAC_8_County_Census_Urban_Areas_2009	Polygon
HGAC_8_County_Census_Urban_Areas_2010	Polygon
HGAC_8_County_Census_Zip_Codes_2010	Polygon
HGAC_8_County_City_Boundaries	Polygon
HGAC_8_County_City_Boundaries_Clipped	Polygon
HGAC_8_County_City_Ordinance_Areas	Polygon
HGAC_8_COUNTY_COASTAL_VIGNETTE	Raster
HGAC_8_County_Coastal_Vignette_50_25	Polygon
HGAC_8_County_Coastline	Polygon
HGAC_8_County_Coastline_Boundary	Polygon
HGAC_8_County_Comprehensive_Plan_2010_pts	Point
HGAC_8_County_Eco_Types	Polygon
HGAC_8_County_Forecast_Cities_h	Table
HGAC_8_County_Forecast_Cities_v	Table
HGAC_8_County_Forecast_Counties_h	Table
HGAC_8_County_Forecast_Counties_v	Table
HGAC_8_County_Forecast_G025M_h	Table
HGAC_8_County_Forecast_G1_h	Table
HGAC_8_County_Forecast_G10K_h	Table
HGAC_8_County_Forecast_G10K_v	Table
HGAC_8_County_Forecast_G1M_h	Table
HGAC_8_County_Forecast_G1M_v	Table
HGAC_8_COUNTY_FORECAST_LU_G1_H	Table
HGAC_8_County_Forecast_RAZ_h	Table
HGAC_8_County_Forecast_RAZ_v	Table

HGAC_8_County_Forecast_Region_v	Table
HGAC_8_County_Forecast_TAZ_h_2003	Table
Dataset Name	**Type**
HGAC_8_County_Forecast_TAZ_v_2003	Table
HGAC_8_County_Forecast_Tracts_h	Table
HGAC_8_County_Forecast_Tracts_v	Table
HGAC_8_County_Forecast_Zip_Codes_h	Table
HGAC_8_County_Forecast_Zip_Codes_v	Table
HGAC_8_County_G025M	Polygon
HGAC_8_County_G1	Polygon
HGAC_8_County_G10	Polygon
HGAC_8_County_G1M	Polygon
HGAC_8_County_Livable_Centers	Point
HGAC_8_County_Livable_Centers_Areas	Polygon
HGAC_8_County_Major_Rivers	Polyline
HGAC_8_County_Major_Roads	Polyline
HGAC_8_County_PedBike_Improvement_Areas	Polyline
HGAC_8_County_PedBike_Improvement_Locations	Polyline
HGAC_8_County_Pedestrian_Pathways	Polyline
HGAC_8_County_Political	Polygon
HGAC_8_County_Political_Boundary	Polygon
HGAC_8_County_Railroads	Polyline
HGAC_8_County_Raster_Extent	Polygon
HGAC_8_County_RAZ	Polygon
HGAC_8_County_School_Districts_TEA_2010	Polygon
HGAC_8_County_Soils	Polygon
HGAC_8_County_TAZ_2003	Polygon
HGAC_8_County_Tracts_1970	Polygon
HGAC_8_County_Tracts_1980	Polygon
HGAC_8_County_Tracts_2000	Polygon
HGAC_8_County_Tracts_2010	Polygon
HGAC_8_County_Water	Polygon
HGAC_8_County_Water_Detailed	Polygon
HGAC_8_County_Zip_Codes_2000	Polygon
HGAC_8_County_Zip_Codes_2002	Polygon
HGAC_8_County_Zip_Codes_2005	Polygon
HGAC_8_County_Zoning_2010_pts	Point
HGAC_Bastrop_Bayou_Sub_Watersheds	Polygon
HGAC_CRP_Watersheds	Polygon
HGAC_LAND_COVER_10_CLASS_2008	Polygon
HGAC_LAND_COVER_10_CLASS_ROADS_2008	Raster
HGAC_LAND_COVER_3X3_MODE_FILTERED_2008	Raster
HGAC_LAND_COVER_MERGED_6_CLASS_2008	Raster
HGAC_Other_CRP_Monitoring_Stations	Point
HGAC_Sea_Level_Rise_10Ft	Polygon

HGAC_Sea_Level_Rise_15Ft	Polygon
HGAC_Sea_Level_Rise_1Ft	Polygon
Dataset Name	**Type**
HGAC_Sea_Level_Rise_20Ft	Polygon
HGAC_Sea_Level_Rise_25Ft	Polygon
HGAC_Sea_Level_Rise_30Ft	Polygon
HGAC_Sea_Level_Rise_35Ft	Polygon
HGAC_Sea_Level_Rise_3Ft	Polygon
HGAC_Sea_Level_Rise_5Ft	Polygon
HGAC_Sea_Level_Rise_All_Levels	Polygon
HGAC_Sea_Level_Rise_Current_Sea_Level	Polygon
Hurricane_Dolly_Observations	Point
Hurricane_Dolly_Track	Polyline
Hurricane_Ike_High_Water_Measurements	Point
Hurricane_Ike_Observations	Point
HURRICANE_IKE_SALT_BURN_GULF_COAST	Raster
Hurricane_Ike_Storm_Surge_Model_i48_gl2	Polygon
HURRICANE_IKE_STORM_SURGE_MODEL_I48_GL2_RASTER	Raster
Hurricane_Ike_Track	Polyline
Land_Cover_1992_19_Class_NLCD	Raster
Land_Cover_1992_19_Class_NLCD_Corrected	Raster
Land_Cover_1996_22_Class_NOAA	Raster
Land_Cover_2001_15_Class_NLCD	Raster
Land_Cover_2001_15_Class_NLCD_Corrected	Raster
Land_Cover_2001_22_Class_NOAA	Raster
Land_Cover_2005_22_Class_NOAA	Raster
Land_Cover_2006_15_Class_NLCD	Raster
Land_Cover_2011_15_Class_NOAA	Raster
Land_Cover_2011_22_Class_NOAA	Raster
Land_Cover_Change_1992_to_2011_9_Class	Raster
LibCAD_Parcels_Coverage_2007	Polygon
LibCAD_Parcels_Coverage_2007_pts	Point
LibCAD_Parcels_Coverage_2008	Polygon
LibCAD_Parcels_Coverage_2008_Pts	Point
Liberty_County	Polygon
LIBERTY_COUNTY_PARCEL_INFO_2007	Table
Liberty_County_Parcel_Info_2008	Table
Liberty_County_Parcel_Values_2007	Table
Liberty_County_Parcel_Values_2008	Table
Matagorda_County	Polygon
Matagorda_County_Political	Polygon
METRO_LRT_Lines	Polyline
METRO_LRT_Stations	Point
Model_Buildings	Point
Model_Buildings_Rural	Point

Model_Buildings_Uses	Point
Model_Buildings_Uses_Rural	Table
Dataset Name	**Type**
Model_Parcels	Table
Model_Parcels_Acct_Nums	Polygon
Model_Parcels_Acct_Nums_Rural	Table
Model_Parcels_Addresses	Table
Model_Parcels_Addresses_Rural	Table
Model_Parcels_Features	Table
Model_Parcels_Features_Rural	Table
Model_Parcels_Forecast	Table
Model_Parcels_Removed_Merged	Table
Model_Parcels_Rural	Polygon
MontCAD_Parcels_Coverage_2005	Polygon
MontCAD_Parcels_Coverage_2005_pts	Point
MontCAD_Parcels_Coverage_2006	Polygon
MontCAD_Parcels_Coverage_2006_pts	Point
MontCAD_Parcels_Coverage_2007	Polygon
MontCAD_Parcels_Coverage_2007_pts	Point
MontCAD_Parcels_Coverage_2008	Polygon
MontCAD_Parcels_Coverage_2008_Pts	Point
Montgomery_County	Polygon
MONTGOMERY_COUNTY_PARCEL_INFO_2006	Table
MONTGOMERY_COUNTY_PARCEL_INFO_2007	Table
Montgomery_County_Parcel_Info_2008	Table
Montgomery_County_Parcel_Values_2006	Table
Montgomery_County_Parcel_Values_2007	Table
Montgomery_County_Parcel_Values_2008	Table
Montgomery_County_Zones_4	Polygon
NLCD_IMPERVIOUSNESS_2001	Raster
NLCD_IMPERVIOUSNESS_2006	Raster
NLCD_IMPERVIOUSNESS_CHANGE_2006	Raster
NLCD_TREE_CANOPY_2001	Raster
NOAA_Surge_MOM_Galveston_Bay	Polygon
NOAA_Surge_MOM_Matagorda_Bay	Polygon
San_Jacinto_County	Polygon
SEM_User_Input_Point	Point
SEM_User_Input_Polygon	Polygon
SEM_User_Input_Polyline	Polyline
Texas_113th_Congressional_Districts	Polygon
Texas_Census_BlockGroups_1990	Polygon
Texas_Census_BlockGroups_2000	Polygon
Texas_Census_BlockGroups_2010	Polygon
Texas_Census_Blocks_2000	Polygon
Texas_Census_Blocks_2010	Polygon

Texas_Census_School_Districts_2010	Polygon
Texas_Census_Tracts_1990	Polygon
Dataset Name	**Type**
Texas_Census_Tracts_2000	Polygon
Texas_Census_Tracts_2010	Polygon
Texas_Census_Urban_Areas_2009	Polygon
Texas_Coastal_Bathymetry	Point
Texas_Coastal_Vignette_50_25	Polygon
Texas_Coastline	Polygon
Texas_COG_Boundaries	Polygon
Texas_Counties_Coastline	Polygon
Texas_Counties_Political	Polygon
Texas_Highways	Polyline
Texas_Impairment_Streams_2008	Polyline
Texas_Impairment_Waterbodies_2008	Polygon
Texas_Major_Rivers	Polyline
Texas_Map_Extent	Polygon
Texas_State_House_Districts_2012	Polygon
Texas_State_Senate_Districts_2012	Polygon
Texas_Stream_Team_Monitoring_Sites	Point
Texas_Zip_Codes_2005	Polygon
The_Woodlands_Pathways	Polyline
TMDL_Project_Areas	Polygon
TMDL_Project_Areas_Mask	Polygon
TMDL_Watersheds	Polygon
US_State_Boundaries	Polygon
USFWS_Wetlands_2009	Polygon
USFWS_Wetlands_2010	Polygon
USFWS_Wetlands_2011	Polygon
USFWS_Wetlands_2012	Polygon
USGS_HUC_10_Watersheds	Polygon
USGS_HUC_12_Sub_Watersheds	Polygon
USGS_HUC_6_Basins	Polygon
USGS_HUC_8_Sub_Basins	Polygon
USGS_River_Basins	Polygon
USGS_Stream_Gauges_2009	Point
USGS_Stream_Gauges_2010	Point
USGS_Stream_Gauges_2012	Point
USGS_Sub_Watershed_Study_Areas	Polygon
WalkCAD_Parcels_Coverage_2005	Polygon
WalkCAD_Parcels_Coverage_2005_pts	Point
WalkCAD_Parcels_Coverage_2006	Polygon
WalkCAD_Parcels_Coverage_2006_pts	Point
WalkCAD_Parcels_Coverage_2007	Polygon
WalkCAD_Parcels_Coverage_2007_pts	Point

WalkCAD_Parcels_Coverage_2008	Polygon
WalkCAD_Parcels_Coverage_2008_Pts	Point
Dataset Name	**Type**
Walker_County	Polygon
WALKER_COUNTY_PARCEL_INFO_2005	Table
WALKER_COUNTY_PARCEL_INFO_2006	Table
WALKER_COUNTY_PARCEL_INFO_2007	Table
Walker_County_Parcel_Info_2008	Table
Walker_County_Parcel_Values_2005	Table
Walker_County_Parcel_Values_2006	Table
Walker_County_Parcel_Values_2007	Table
Walker_County_Parcel_Values_2008	Table
WallCAD_Parcels_Coverage_2007	Polygon
WallCAD_Parcels_Coverage_2007_Pts	Point
WallCAD_Parcels_Coverage_2008	Polygon
WallCAD_Parcels_Coverage_2008_Pts	Point
Waller_County	Polygon
WALLER_COUNTY_PARCEL_INFO_2007	Table
Waller_County_Parcel_Info_2008	Table
Waller_County_Parcel_Values_2007	Table
Waller_County_Parcel_Values_2008	Table
Wharton_County	Polygon
World_Country_Boundaries	Polygon

C&E Non-Spatial Data
Ambient Surface Water Quality Monitoring
Wastewater Self-reporting Data
Parcel-Based Land Use, Attributes, and Valuation (9 counties)
Census Data

Appendix 6 Data Dictionary

Data Dictionary **Houston-Galveston Area Council** **Community and Environmental Planning Department**

General Information		
Thematic Layer Name		
Feature Class		
Topology		
Table Name		
Data Source		
Report Prepared by		
Phone	Fax	E-Mail

Attribute Table				
Variable	Begin Column	Item Name	Alternate Name	Item Definition

Data History
Source Agency
Originating Date

Originating Scale

Status Information
Percentage Complete
Planned Completion Date
Geographic Extent
Planned Enhancements
Known problems or limitations

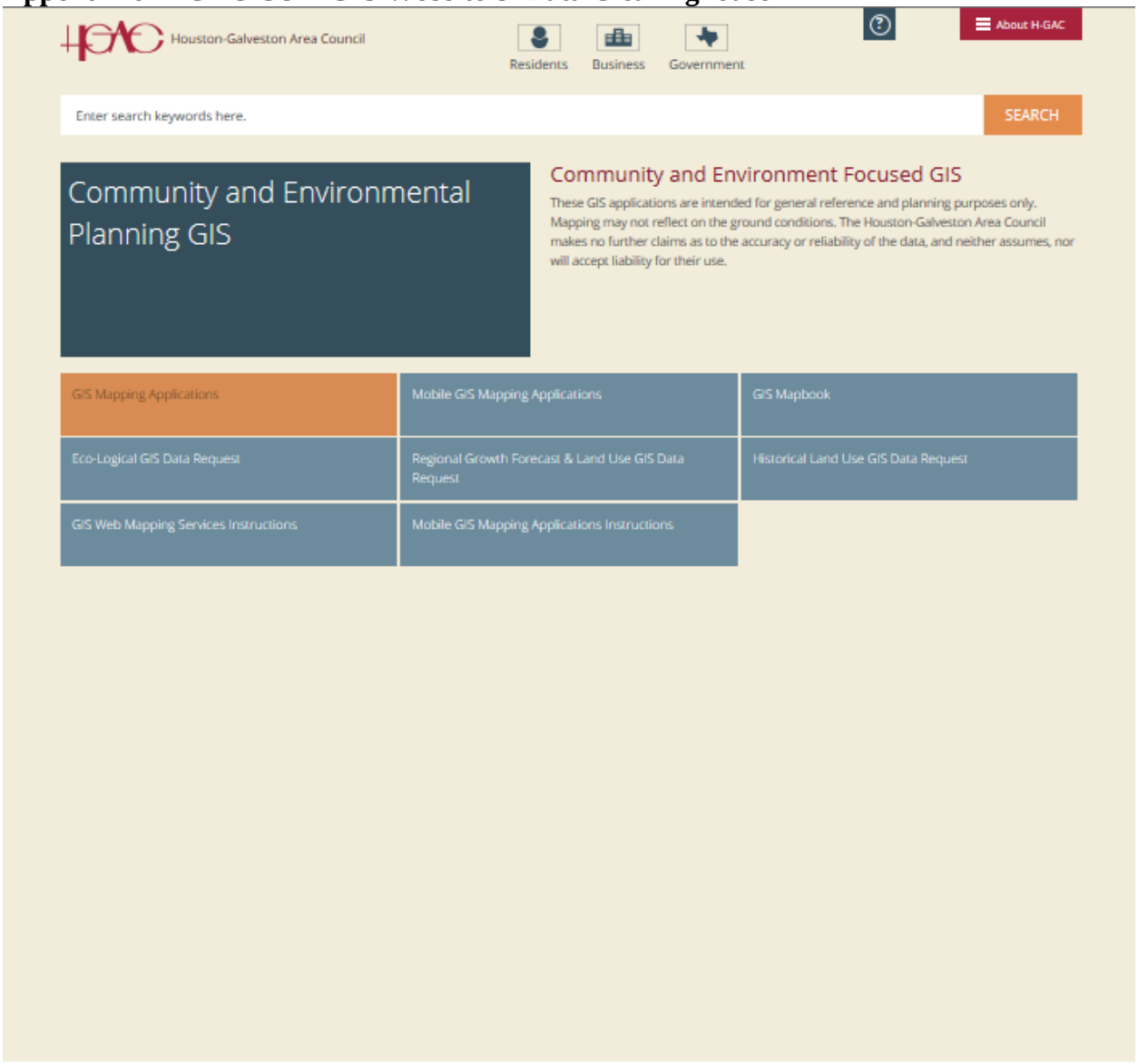
Maintenance Information
Maintaining Office/Division/Section
Contact Name
Contact Telephone Number
Type of updates performed
Frequency of Updates

Data Format Information
Data Format
Software/Version
Number of features/records
Total File Size

Projection
Geographic Projection:
Spheroid:
Zone:
Datum:
Units:
Fips Zone:
Quadrant:
X Shift:
Y Shift:
1st Standard Parallel:
2nd Standard Parallel:
Central Meridian:
Lat. of Projection Origin:
False Easting:
False Northing:

Additional Documentation
Quality Assurance Quality Control
Attribute Reports Available
Additional Documentation Available

Appendix 6 H-GAC C&E GIS Website & Data Clearinghouse



APPENDIX B - ADHERENCE LETTER

Appendix B. Example Letter to Document Adherence to the QAPP

TO: *(name)*
(organization)

FROM: *(name)*
(organization)

RE: Contractor Name, QAPP Title

Please sign and return this form by (*date*) to:

(*Address)*

I acknowledge receipt of the "QAPP Title, Revision Date". I understand the document describes quality assurance, quality control, data management and reporting, and other technical activities that must be implemented to ensure the results of work performed will satisfy stated performance criteria.

My signature on this document signifies that I have read and will comply with the document contents pertaining to my program. Furthermore, I will ensure that all staff members participating in modeling activities will be required to familiarize themselves with the document contents and adhere to them as well.

_____

Signature Date

APPENDIX C – SCHEDULE OF DELIVERABLES

Appendix C. Schedule of Deliverables

This schedule of deliverables is included in Cooperative reimbursement contract #582-15-56349 between the Houston-Galveston Area Council and the Texas Commission on Environmental Quality.

Schedule of Deliverables

Task No.	Deliverable	Due Date
1. Project Administration		
1.2	QPR's	The 15th of the month following each state fiscal quarter
1.3	Reimbursement Forms	Within 30 days following each state fiscal quarter. For the last reporting period of the project, reimbursement forms are required to be on a monthly basis
1.4	Post-Award Orientation Meeting and notes	Meeting within 30 days of Contract execution, notes in subsequent QPR
1.4	Quarterly call or meeting and notes	Quarterly, after the call
1.4	Contract Closeout Strategy	The first quarter of the last year of the project
1.5	EPA Coordination Meeting	TBD
1.6	Annual Report Article	Upon Request
2. Quality Assurance		
2.1	QAPP Planning Meeting and notes	Meeting within 30 days of Contract execution, notes after the meeting
2.2	Draft Data Acquisition QAPP	120 days or more prior to the scheduled initiation of environmental data operations
2.2	Final Data Acquisition QAPP	Quarter 3 of the Contract
2.3	Draft Modeling QAPP	120 days or more prior to the scheduled initiation of environmental data operations
2.3	Final Modeling QAPP	Quarter 3 of the Contract
2.4	Annual Review Certification	no less than 90 days prior to the QAPP annual anniversary date
2.5	Draft QAPP Amendments	90 days prior to the scheduled initiation of changes or additions to activities listed in the current QAPP
2.5	Final QAPP Amendments	Within 30 days of receipt of TCEQ comments
3. Water Quality Data and Information Collection, Acquisition, and Evaluation		
3.1	Draft Acquired Modeling Data Report	Quarter 4 of the Contract
3.1	Final Acquired Modeling Data Report	Quarter 5 of the Contract
3.2	Draft Data Collection and Trends Analysis Report	Quarter 7 of the Contract
3.2	Final Data Collection and Trends Analysis Report	Quarter 8 of the Contract
4. Modeling		
4.1	Modeling Methodology Description Analysis	Quarter 3 of the Contract
4.2	Updated Load Duration Curves	Quarter 8 of the Contract
4.3	SELECT Modeling	Quarter 8 of the Contract
4.4	Modeling Support Document (Interim)	Quarter 7 of the Contract
4.5	Draft Modeling Report	Quarter 9 of the Contract
4.5	Final Modeling Report	Quarter 9 of the Contract

Task No.	Deliverable	Due Date
5. Stakeholder Outreach		
5.1	PPP	Quarter 3 of the Contract
5.2	Stakeholder Contact List, updated in QPR	Quarters 1-13 of the Contract
5.3	Documentation of Communication with Stakeholders including direct emails and distributed educational materials	Quarters 1-13 of the Contract
5.4	Documentation of Stakeholder Meetings, including meeting notices, materials, agendas, attendance lists, and summaries	Quarters 1-13 of the Contract
5.5	Summary of Public Meetings Attended (approximately 6)	Quarters 1-13 of the Contract
6. Watershed Protection Plan Development		
6.1	Draft nine element WPP to Stakeholder Group	Quarter 10 of the Contract
6.1	Draft nine element WPP to TCEQ	Quarter 11 of the Contract
6.1	Draft nine element WPP to EPA	Quarter 12 of the Contract
6.1	Response to stakeholder, TCEQ, and EPA comments on draft WPP	Within 30 days of receipt
6.1	Final WPP	Quarter 13 of the Contract
6.1	Documentation of stakeholder approval of Final WPP	Quarter 13 of the Contract
6.2	Executive Summary	Quarter 11 of the Contract
6.3	Documentation of distribution of Final WPP and Executive Summary to Stakeholders	Quarter 13 of the Contract
7. Final Report		
7.1	Draft Final Report to TCEQ	Quarter 13, Month 1 of the Contract
7.2	Address TCEQ comments	Within 30 days of TCEQ comments
7.2	Final Report	Quarter 13, Month 3 of the Contract