1.0 Characterizing Impacts from the Plant

Background

The Science Panel has agreed that in general the impact from the Plant's discharge and nutrient load could be quite small given 1) the effluent may not always reach the open waters of Willard Spur, 2) there may be significant uptake of the effluent's nutrients before the effluent reaches the open water, 3) nutrient loads from other sources greatly surpass the Plant's input, and 4) Willard Spur appears to be processing the overall nutrient load with minimal impacts. A possible scenario where the Plant could have an impact is if the Plant's full nutrient load does reach the open water of Willard Spur (i.e., no evaporation and little to no uptake of nutrients between the Plant and open water) during the critical months of July – September of a very dry year (e.g., 2012).

The year 2013 presents an opportunity to assess the Plant's potential impacts in the detail required to answer this important question. Current water supply forecasts for 2013 indicate that flows could be very similar to the very low inflow conditions observed in 2012, thus there is an opportunity to further evaluate a scenario where the Plant could potentially have an impact.

Objective

One of the key objectives of the entire Willard Spur research project was to answer the question: *What are the potential impacts of the Perry Willard Regional Wastewater Treatment Plant on Willard Spur?* Answering this question is the objective for this element of the 2013 Research Plan. The following summarizes the tasks to be completed and questions to be answered in 2013.

Tasks

1. CH2M HILL will meet with the Plant to discuss and confirm the following:
    a. Will the Plant discharge its effluent in 2013 to the outfall ditch, private wetlands, or Willard Bay tailrace channel?
        i. Meet with the Plant to outline operations scenarios and anticipated schedule for 2013 and the future.
        ii. Discuss possible flexibility for experiments outlined below with the Plant. Effluent will need to flow in each of the three discharge locations (ideally for a period of 2 weeks) to determine how nutrients are assimilated within each location and what the nutrient load is that reaches the waters of Willard Spur.
        iii. Confirm existing UPDES permit requirements relating to discharge location.
    b. Confirm the history of the Plant's outfall ditch and site
        i. How long has the Plant outfall ditch been used? Does Willard City have any flow or water quality data for lagoon effluent discharged into the ditch?
        ii. Can the Cities identify an individual(s) who would know:
            1. The historical development/growth of the existing phragmites patch near the confluence of the irrigation ditch and Plant outfall ditch?
            2. How frequently the phragmites patch/mudflat is inundated by rising Willard Spur water levels?
            3. How frequently the water from the Plant outfall ditch and irrigation ditch evaporates and fails to reach the waters of Willard Spur?
        iii. Do the Cities have any site surveys, historical topographical mapping and/or aerial photographs that might show the vertical profile, the historical use of the Plant outfall ditch or the irrigation ditch to the west, and growth of the phragmites patch near their confluence?

c. Confirm the following future scenarios to be used in the evaluation of potential future impacts.

TABLE 1
Anticipated Flow Scenarios from Willard Perry Regional Wastewater Treatment Plant

Scenario	Flow Rate	Timing
Low Flow	0.35 MGD	Perry City only (2010)
Medium Flow	0.60 MGD	Perry and Willard (2011)
Ultimate Flow	2.00 MGD	Maximum Capacity (2030)

Note: values taken from DWQ memorandum dated September 30, 2010

TABLE 2
Anticipated Scenarios for Effluent Nutrient Characteristics (mg/L) from Willard Perry Regional Wastewater Treatment Plant

Scenario	TP	TN	NO3	NH4	Notes
Low Levels with Chemical Removal	2.5	10	8	0.1	Levels based on specifications for the STM-Aerotor™
Medium Levels without Chemical Removal	4.0	20	16	1.0	Levels based upon average from four similar UT Plants
High levels - Conservative	5.0	30	24	3.0	

Note: values taken from DWQ memorandum dated September 30, 2010

d. Evaluate the potential contribution of the irrigation ditch located between BRMBR and the Plant to possible impacts observed near the Plant outfall ditch.
   i. What is the source of water in the irrigation ditch? Is it natural drainage, irrigation return flow, and/or are there water rights associated with this water?
   ii. Can the Cities identify an individual(s) who would know the historical use of and flow rates and patterns in the ditch?
   iii. How are flows in the irrigation ditch expected to change in the future?
e. Discuss the Plant's cooperation in making weekly observations of how far the combined waters from the Plant's outfall ditch and irrigation ditch extend across the mudflats before reaching the waters of Willard Spur. This would include the following:
   i. Weekly inspection of the outfall site and identification of the downstream (southern) extent of visible water from the two ditches.
   ii. Placement of a small flag at this location, take photographs, possible GPS location and sketch on site map
f. Identification of the characteristics of the private wetlands discharge site.
   i. Does the Plant have a topographical map of the site that would indicate the aerial extent of water in the wetlands, inflow and outflow sites?
   ii. Complete a site visit with DWQ to confirm potential locations where flow could exit and enter the open waters of Willard Spur.
g. Identify the location and characteristics of other nearby ponds (or lagoons?) possibly contributing flow and nutrients to Willard Spur

h. Provide 2013 effluent flow rates, water quality characteristics, and timeline of location of discharge point

2. DWQ will complete the following tasks as part of its Willard Spur monitoring and sampling program:

   a. Standard measurement of flow rate and water quality monitoring per the 2013 sampling plan (minimum monthly basis) for the following inflow sites:

      i. Irrigation ditch between the Plant and BRMBR

      ii. Plant's outfall ditch

      iii. Willard Bay outlet

      iv. Willard Bay outlet channel

   b. Evaluation of sediment characteristics in sheetflow wetlands downstream of confluence of irrigation ditch and Plant outfall ditch:

      i. Collect sediment samples along a transect beginning at the confluence of the Plant's outfall ditch and irrigation ditch and following the water flowpath. Sediment samples will be collected at points representing the 10%, 50% and 90% distance along this flowpath. Each sample will represent the top 5 cm of sediment. A fourth samples will be collected at the 90% location but will represent a sediment core extending a minimum of 20 cm in depth. Analysis will be for salinity, TOC, and nutrient characteristics. Split 20cm sediment core into four successive and distinct 5cm samples for analysis. If the flow from these sources is not reaching the open waters of Willard Spur, an additional sediment sample will be collected at a point halfway between the end of open water from the ditches and edge of water of Willard Spur (note depth of groundwater).

      ii. Collect sediment samples from three locations along a transect approximately 0.25km east and parallel to the combined ditch transect noted above. This site should have historic sediment characteristics and similar grazing patterns and Willard Spur inundation characteristics as the ditch outfall but not have the freshwater sheetflow of the ditch outfall. Samples should be collected on the same day and with similar numbers and methods as those from the ditch outfall transect.

   c. If water from the irrigation and Plant outfall ditches does reach the open water of Willard Spur, is it possible to trace its impact?

      i. Harvest five leaves in first 2 weeks of July from dominant plant species at the following sampling sites: WP-OUTFALL (end of Plant outfall ditch), OUTFALL-CNFL (confluence of outfall ditch flow and Willard Spur), OUT-WB-TAILRACE (outside Willard Bay tailrace in open water), WS-1 (open water site), WS-1D (open water site), WS-2 (open water site). Sample mature leaf (fully expanded leaf 1-3 nodes below the top of plant, or the top 30cm of culm (for Schoenoplectus spp.)). Analyze leaf samples for C, N, and P concentration, and δ15N and δ13C isotope ratios. Evaluate results and determine if there is a Plant effluent signature in samples that can be used to determine an influence from the Plant's effluent.

      ii. Inject a dye tracer into the flow from the Willard Bay outlet channel (i.e., tailrace) on two separate occasions (June and August) where this flow reaches the waters of Willard Spur. Observe and describe mixing characteristics with Willard Spur. Measurements of dye concentration are not required. Collect three water samples along the identified flowline at 10%, 50%, and 90% points between confluence with waters of Willard Spur and the WS2 open water site. Goal is to generally understand how the flow mixes with the waters of Willard Spur, i.e., does the water generally stay close to the shoreline, follow the flow along the southern edge of Willard Spur, or rapidly mix with inflows from BRMBR? Is the zone of impact largely limited to the shoreline or can it be assumed that the flow is well mixed with Willard Spur?

      NOTE: The need for the following two experiments will be evaluated after discussions with the Plant.

      iii. Inject a dye tracer into the flow from the irrigation/Plant outfall ditches on two separate occasions (June and July) where this flow reaches the waters of Willard Spur. Observe and describe mixing characteristics with Willard Spur. Measurements of dye concentration are not required. Collect three water samples along the identified flowline at 10%, 50%, and 90% points between confluence with waters of Willard Spur and the WS2 open water site. Goal is to generally understand how the flow mixes with the waters of Willard Spur, i.e., does

the water generally stay close to the shoreline, follow the flow along the southern edge of Willard Spur, or rapidly mix with inflows from BRMBR? Is the zone of impact largely limited to the shoreline or can it be assumed that the flow is well mixed with Willard Spur?

iv. If the private wetlands do have a discharge point, inject a dye tracer into the flow from these wetlands on two separate occasions (June and July) where this flow reaches the waters of Willard Spur. Observe and describe mixing characteristics with Willard Spur. Measurements of dye concentration are not required. Collect three water samples along the identified flowline at 10%, 50%, and 90% points between confluence with waters of Willard Spur and the WS2 open water site. Goal is to generally understand how the flow mixes with the waters of Willard Spur, i.e., does the water generally stay close to the shoreline, follow the flow along the southern edge of Willard Spur, or rapidly mix with inflows from BRMBR? Is the zone of impact largely limited to the shoreline or can it be assumed that the flow is well mixed with Willard Spur?

d. Evaluation of nutrient uptake capacity

i. Evaluate nutrient uptake in the Willard Bay outlet channel (i.e., tailrace). The Plant will discharge its effluent into this channel for a minimum period of 2 weeks. After operating for one week, DWQ will sample water quality and measure flow along the channel at a minimum of five locations. The project team will evaluate whether adding nutrients and a tracer to the pipeline outfall will be helpful in evaluating the nutrient uptake capacity of the channel.

NOTE: The need for the following two experiments will be evaluated after discussions with the Plant.

ii. Evaluate nutrient uptake in the Plant's outfall ditch. The Plant will discharge its effluent into this ditch for a minimum period of 2 weeks. After operating for one week, DWQ will sample water quality and measure flow along the ditch at a minimum of five locations. The project team will evaluate whether adding nutrients and a tracer to the eastern (upstream) end of the ditch will be helpful in evaluating the nutrient uptake capacity of the ditch.

iii. Evaluate nutrient uptake in the private wetlands the Plant may discharge to. The Plant will discharge its effluent into the private wetlands for a minimum period of 2 weeks. A dye tracer will be added to the effluent to determine mixing patterns and possible location of an outfall to Willard Spur. Flow characteristics (depth and velocity) will be measured along the flowline. Residence time will be estimated. After operating for one week, DWQ will sample water quality along the determined flowline of the wetlands at a minimum of five locations. If there is flow through the wetlands, the project team will evaluate whether adding nutrients and a tracer to the upstream end of the wetlands will be helpful in evaluating the nutrient uptake capacity of the wetlands.

3. Task 3 integrates information from Tasks 1 and 2 to answer the questions identified in the 2013 Research Plan. Figure 1 illustrates where the questions from Task 3 are linked to the project site. The following questions will be answered via evaluations completed at the conclusion of the sampling/experimental season:

a. What are the Plant's nutrient loads in relation to other sources in the vicinity of the Plant's outfalls? What were the Plant's loads historically? What could the Plant's loads be in the future?

i. Revise 2011 and 2012 nutrient load estimates to account for estimated load assimilation prior to effluent reaching the waters of Willard Spur.

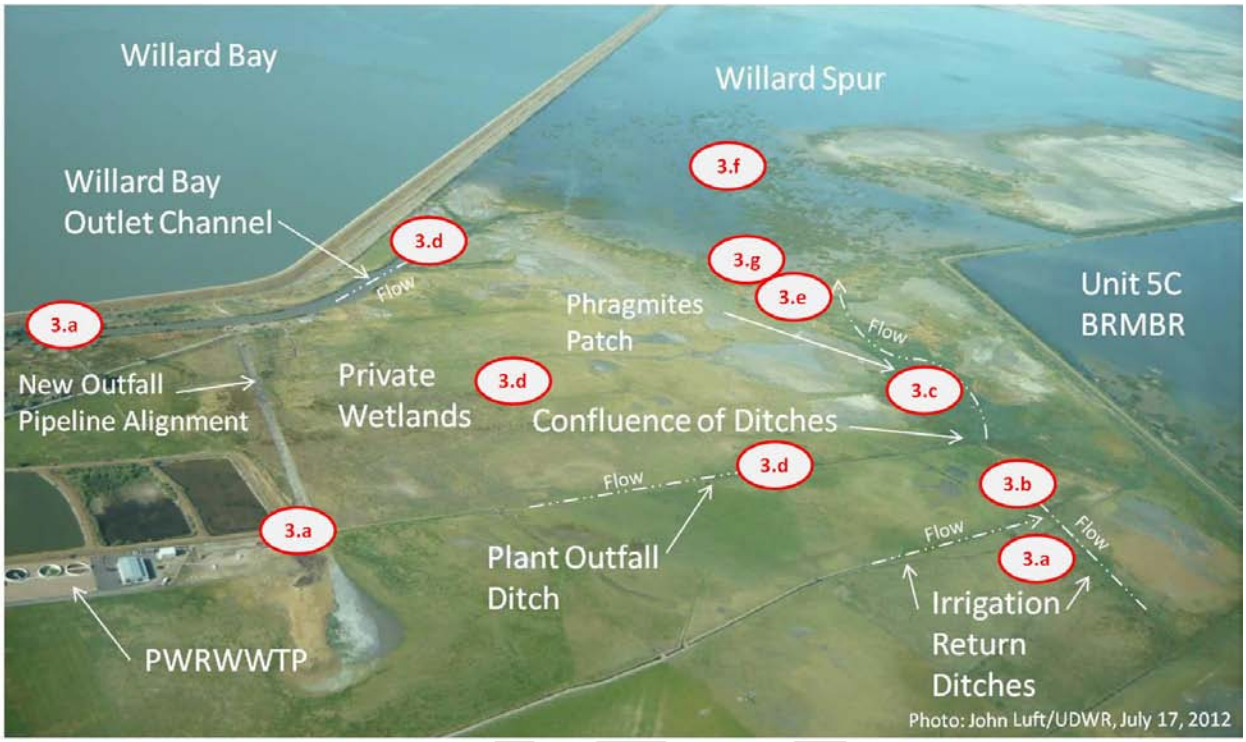
ii. Estimate 2013 nutrient loads from the Plant based upon reported effluent flow and water quality characteristics, discharge location, and accounting for estimated load assimilation prior to effluent reaching the waters of Willard Spur.

iii. Estimate 2013 nutrient loads from Willard Bay and the irrigation ditch located between the Plant and BRMBR.

iv. Evaluate historical observations and available flow rate and water quality data for the old Willard City lagoon effluent to define historic flow patterns and nutrient load. How significant was this nutrient load in the past?

v. Revise future nutrient load estimates to account for updates from the Plant, discharge location, and estimated load assimilation prior to effluent reaching the waters of Willard Spur.

Figure 1
LINKAGE BETWEEN RESEARCH QUESTIONS AND PROJECT SITE



b. How could the irrigation ditch between BRMBR and the Plant contribute to possible impacts from the Plant?

   i. Evaluate historic observations and available flow data for the irrigation ditch between the Plant and BRMBR to define historic flow patterns and nutrient load. How significant of a factor is this flow and associated nutrient load in relation to the Plant's discharge?

   ii. Compare history of the operation of the irrigation ditch with history of the associated phragmites patch.

c. How have the irrigation ditch and Plant outfall ditch contributed to the existing phragmites patch at the confluence of these ditches?

   i. Evaluate historic observations and aerial photography of the phragmites patch located at the confluence of the Plant outfall ditch and irrigation ditch.

   ii. Karen Kettenring will confirm the presence of phragmites at this site in 2013 and confirm 2011 aerial vegetation mapping.

   iii. Evaluate results from sediment samples collected by DWQ along two transects described above and compare with sediment samples collected outside HCWMA. Is the phragmites patch near the Plant outfall ditch primarily due to nutrients, available water, and/or inundation patterns from Willard Spur?

d. How much is the Plant's nutrient load to the open waters of Willard Spur reduced by natural uptake in the outfall ditch, private wetlands, and Willard Bay outlet channel?

   i. Estimate a nutrient assimilation rate for measured conditions.

   ii. Evaluate how estimated nutrient assimilation in these ditches/wetlands may change the estimated nutrient loads from the Plant to the waters of Willard Spur.

e. Does the Plant's effluent reach the open waters of Willard Spur? How does it change seasonally?

   i. Evaluate observations of the confluence of the irrigation/Plant outfall ditch with the waters of Willard Spur. Estimate period where this flow did not reach Willard Spur and the necessary conditions for this to happen.

ii. Estimate evaporation rates for flow across this mudflat.

iii. Evaluate sediment sample results from the two outfall transects. How much of the nutrient load from these ditches reaches Willard Spur and when? From sediment sample results, how much of the nutrient load is deposited and could be remobilized when inundated again?

f. If water from the irrigation and Plant outfall ditches does reach the open water of Willard Spur, is it possible to trace its impact?

i. Evaluate observations of dye dispersion, water quality samples collected along transects downstream of the discharge site, and leaf isotope analyses to characterize how effluent from the Plant disperses and is assimilated in Willard Spur. Consider impact of actual discharge location in analysis.

g. Can sediment be used to monitor long term trends and possible future impacts from the Plant?

i. Evaluate all sediment samples collected east of the WS2 open water site in 2011-2013 to evaluate spatial and temporal characteristics. Consider how depth of sediment samples may influence results (5cm [2012-2013] vs 10cm samples [2011]). Evaluate changes in sediment chemistry with depth.

ii. Recommend locations for sediment sampling sites to be used in future monitoring of Willard Spur and impacts from the Plant.

DELIVERABLES

A technical memorandum will be prepared to summarize the efforts completed and observations and conclusions that can be made from the work completed in 2013.

SCHEDULE

It is not anticipated that the complete data package from the 2013 field sampling and experimental efforts will be available until January 31, 2014. A draft memorandum will be completed for review by March 30, 2014. The Science Panel will have the opportunity to review and comment until April 30, 2014. The text from the draft memorandum will be incorporated into the draft project report to be available for review by June 30, 2014.