Integrated Wastewater Management in Coastal Arid Areas and Water Reuse in Alexandria, Southern Mediterranean

Nabil M. Ismail, Ph. D.,[1] Helalley A. Helalley, Ph. D.[2]

[1]Professor of Coastal Engineering and Water Resources Management, Maritime Academy for Science & Technology, Director, Costamarine Technologies, Davis, CA 95618, USA, e-mail: nbismail@usa.net, nmismail@aast.edu

[2]Chief of Industrial Wastewater Management, Alexandria Sanitary Drainage Co, Alexandria, Egypt, e-mail: drhelaley@yahoo.com

Presentation Outline

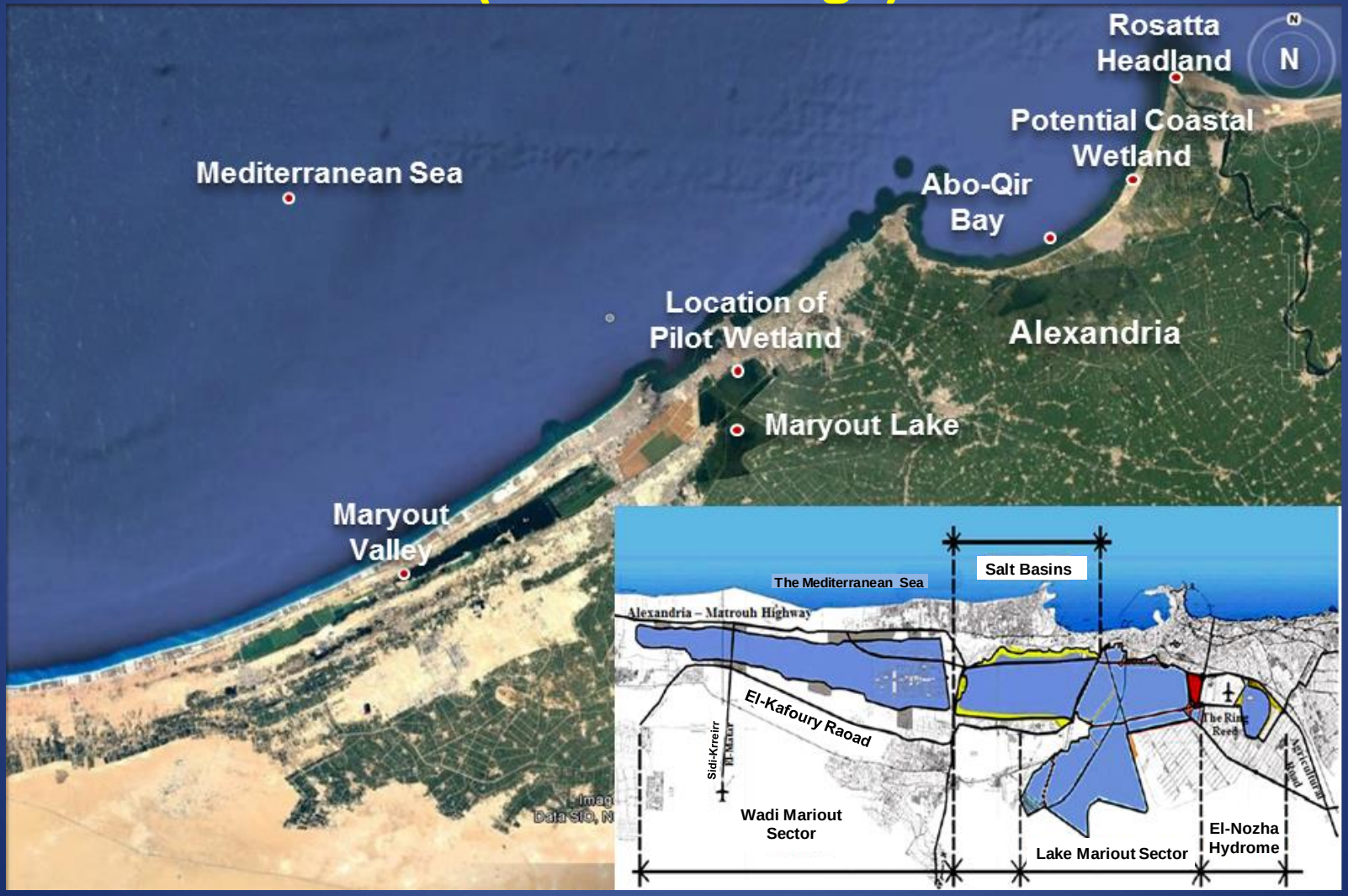
- Objectives and Locations of Project Sites in Alexandria, California.
- Motivations for the Use of Wetlands for Natural Wastewater Treatment.
- Overview of Existing Conventional Treatment Plants for Wastewater in Alexandria Governorate and Pollution Sources to the Lake & Coast.
- Design Features of the Integrated Pilot Wetland Facility, Completed in November 2016 at Lake Maryout by Alexandria Coast, which receives primary treated wastewater of 50,000 m^3/day.
- Review of Startup Results of Water Quality Parameters of the Alexandria Pilot Wetland Effluent and Comparison with the Performance of the Wastewater- Natural Treatment Facility Located at Arcata Bay, CA.
- Outlook for Future Plans for the use of Bio-Solids for the Rehabilitation/Construction of Coastal Wetlands. Planning for the Use of Satellite Constructed Wetlands in Maryout Valley, adjacent to Lake Maryout to Polish the Water Quality of Secondary Treated Wastewater Prior to Reuse or Disposal.

Overreaching Objectives : Pollution Control & Water Resources Management

- The main objective of the paper is to **report on the design, construction and start up of a pilot wetland for natural treatment in conjunction with a Biofilm facility** for treatment of primary treated wastewater at Lake Maryout shores, Alexandria with similar design flow conditions for the Arcata integrated natural treatment pond/wetland in California; from primary to advanced.
- Provide a basis for acceptable environmental economical alternatives to the discharge of partially treated wastewater into coastal lagoons, coastline, lakes and to acquire sustainable solutions for wastewater recycling.
- Formulate plans for the use of constructed wetlands on a larger scale in the Maryout Valley (1-4m below sea-level), adjacent to Lake Maryout. Such mega wetland project will reduce progressive seawater intrusion into coastal aquifers.

Site Location of Lake Maryout and Maryout Valley, Alexandria, Egypt

(Satellite Image)



Sample Photos of Lake Maryout, Maryout Valley, Alexandria, Egypt (October 2016)

Motivation for Wetland Projects at Maryout Lake, Alexandria and at Arcata Bay/Humboldt, CA

- **Increased pressures of population growth in Alexandria Governorate, lack of strategic plans for urban expansion and enforced environmental regulations.** Due to lake Maryout's proximity**,** it has been most popular for land reclamation & city expansion and wastewater & agricultural/industrial drainage, wasting an important water body resource.

- **Conflicting interests** of industry, fishing, and urban residential expansion called for an **integrated planning system to lake rehabilitation, pollution control** in coastal regions using conventional/constructed wetlands for secondary/advanced treatment and reuse of treated wastewater in rural coastal areas.

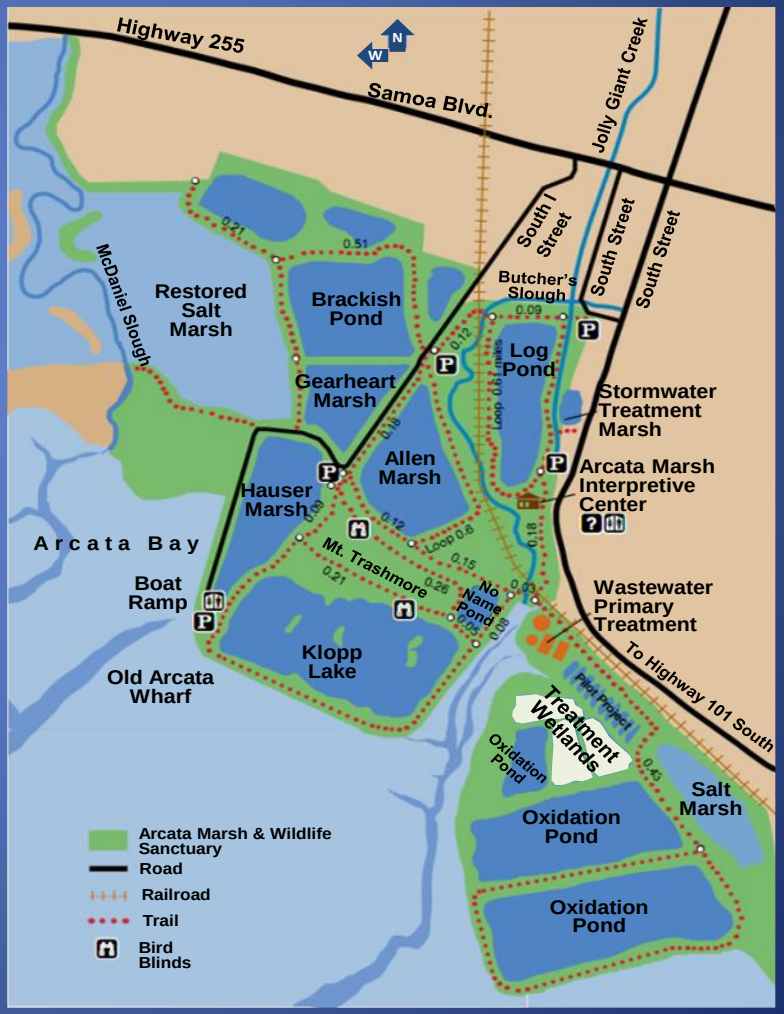
Motivation for Wetland Projects at Maryout Lake, Alexandria and at Arcata Bay/Humboldt, CA

- Constructed wetlands, when land is available, provide a relatively economical and efficient polishing step and an important additional barrier to contaminants in municipal wastewater, before the reuse of the effluent or disposal to coastal lagoons.

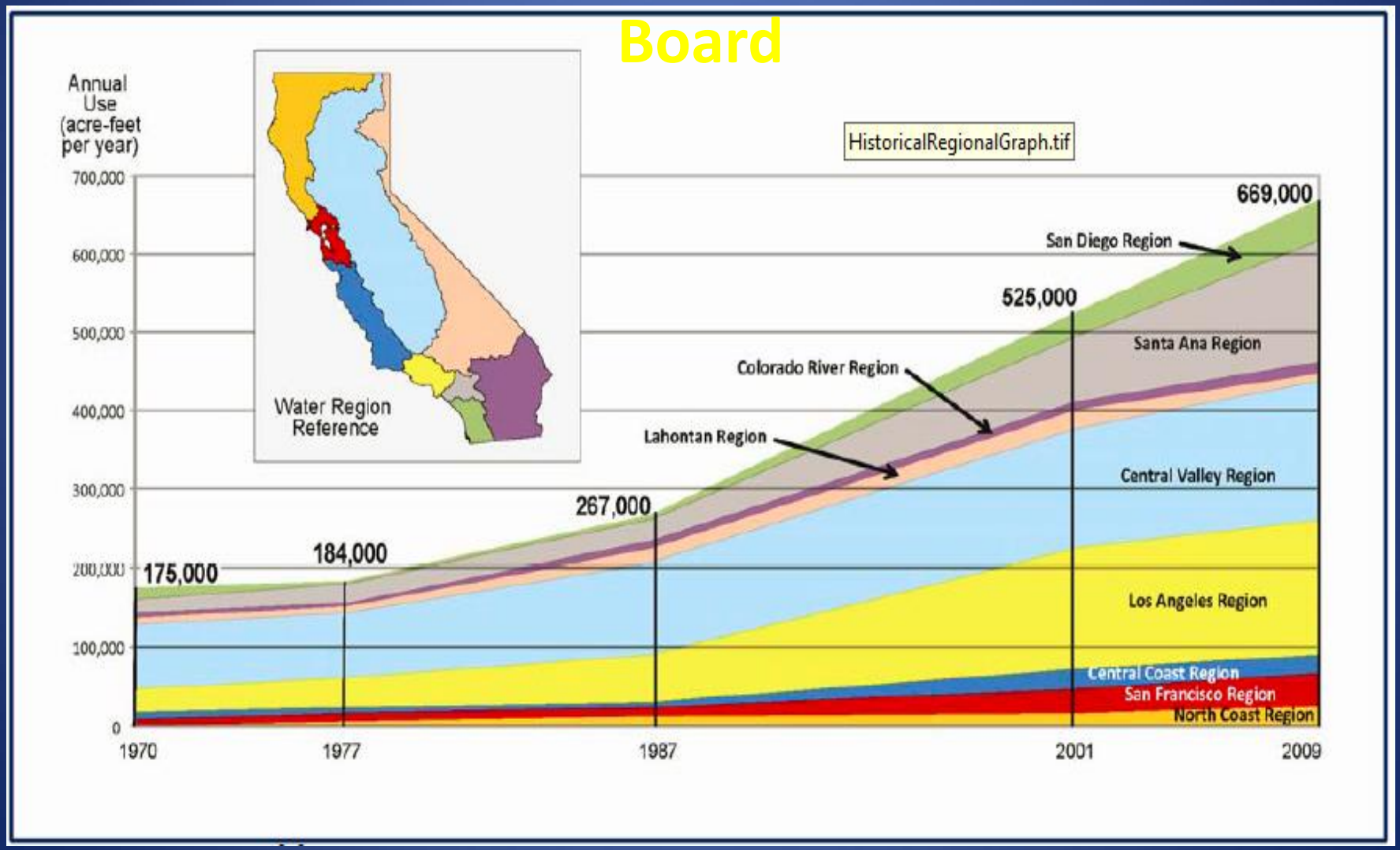
- The city of Arcata, California was faced with a dilemma; Buy into an expensive conventional sewage treatment plant to bring their wastewater discharge into Arcata Bay up to acceptable water quality standards. They embarked o a pioneering project in 1965 of an integrated natural wastewater treatment of three phases. The created wetlands provide additional benefits, including environmental enhancement, habitat for plants and animals and passive recreational opportunities for the community.

Arcata Wastewater Marsh Wetland, California Coastline, USA

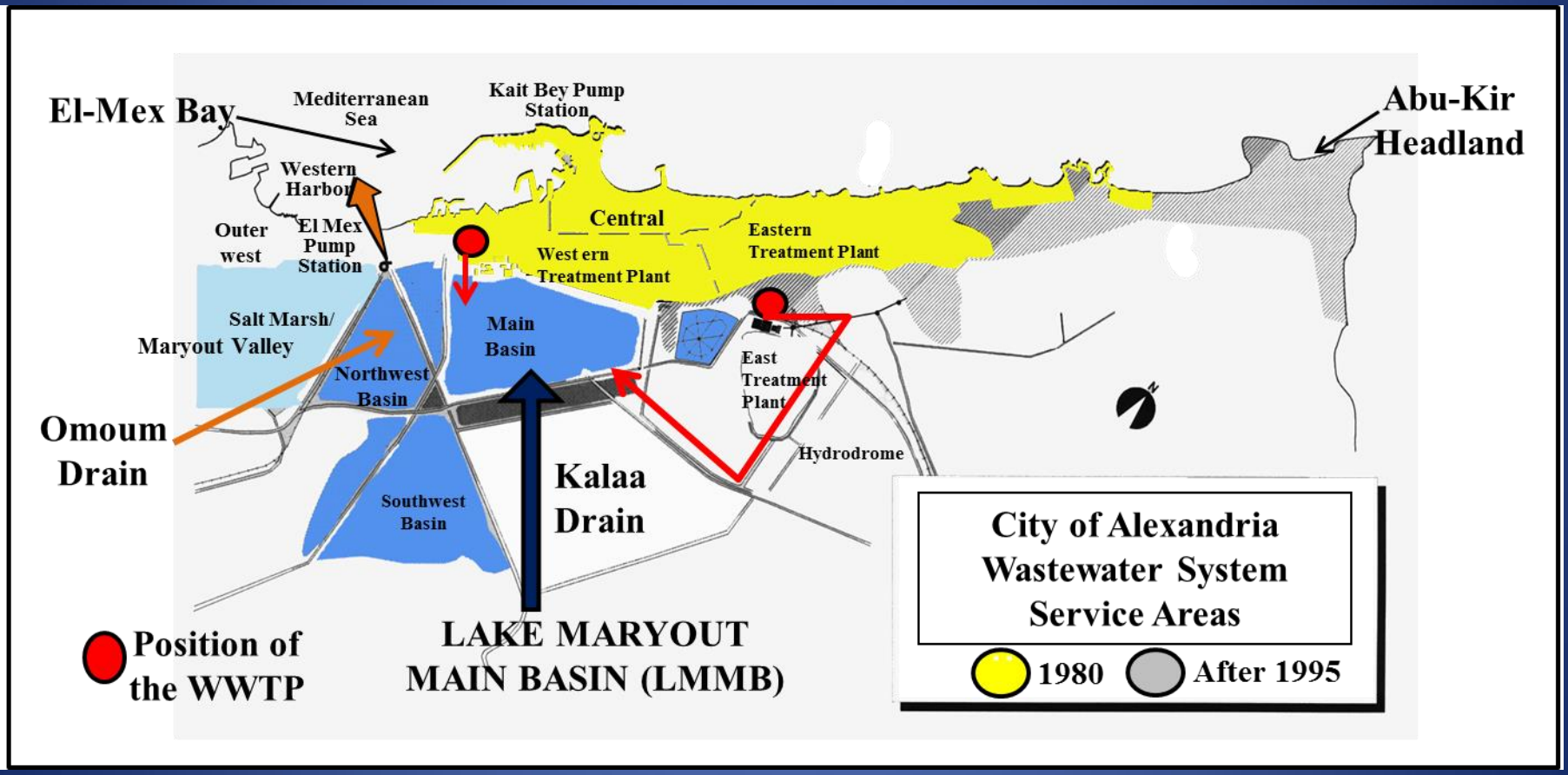
Humboldt Bay, with Barrier Islands CA, and Arcata Natural Treatment of Arcata Wastewater



Historic Increase in Recycling of Municipal Wastewater by Regional Water Quality Control Board

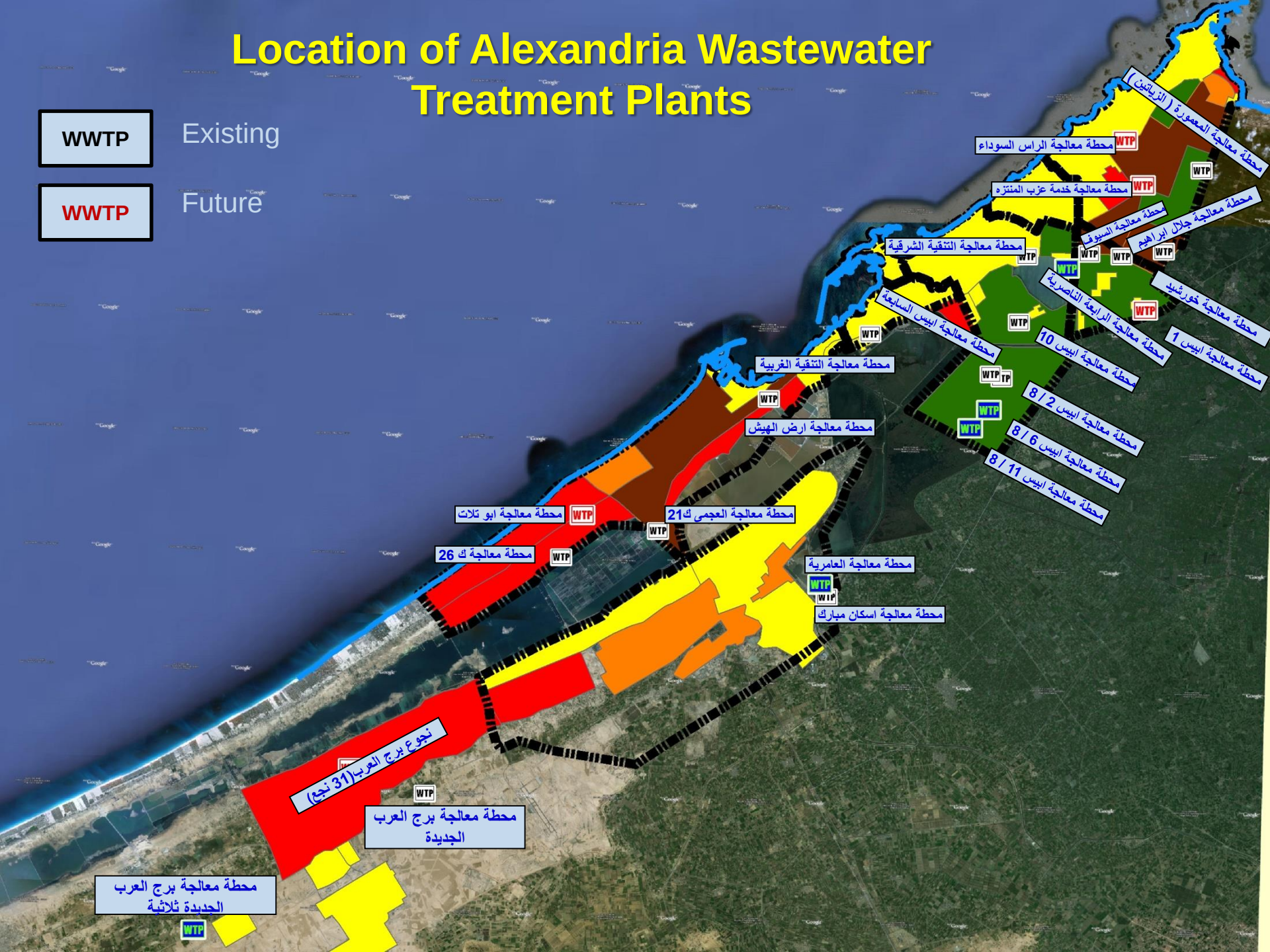


Major Wastewater Treatment Plants & Discharge of Excess Water in Lake Maryout into the Western Main Harbour of Alexandria



Alexandria Major Wastewater Treatment Plants

Location of Alexandria Wastewater Treatment Plants



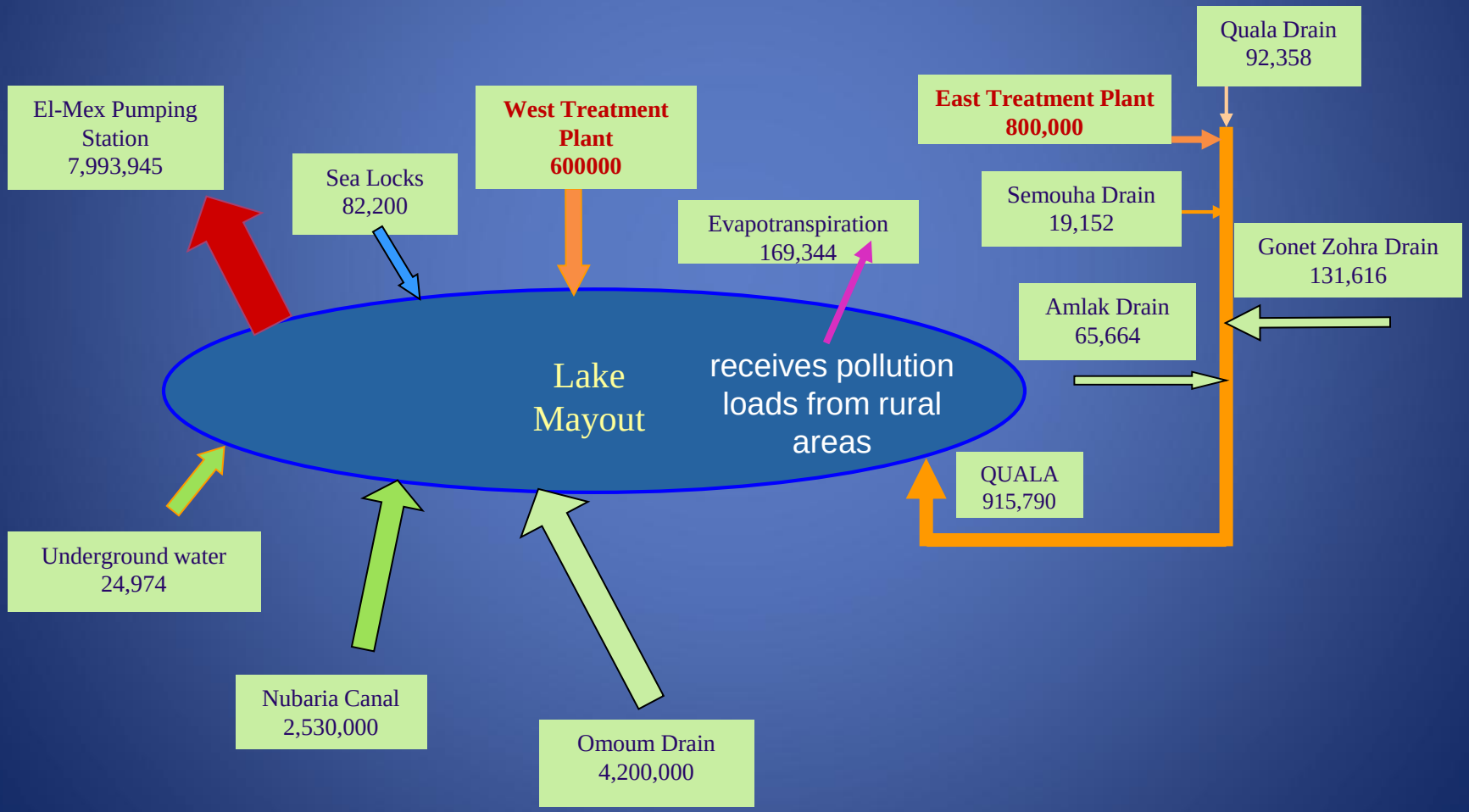
Capacity of Major Wastewater Treatment Plants in Alexandria

Plant	Type	Operating capacity ($m^3\ d^{-1}$)	Design capacity ($m^3\ d^{-1}$)
West WWTP	Primary treatment, (Secondary treatment – Design phase)	450000	605000
East WWTP	Primary treatment Secondary treatment	807000	1000000
Eskan Mubarak WWTP	Secondary treatment	15000	15000
Hanoville WWTP	Secondary treatment	20000	20000
El Agamy WWTP	Secondary treatment	210000	210000
El Amreya WWTP	Secondary treatment	75000	120000
National Permissible Limits for Effluents Disposal in Water Bodies (Law 48,1982): pH :6-9, TSS: 50 mg/l, COD: 80 ppm, BOD: 60ppm, S: 1.0 ppm, Total Coliform: 5000 ml Plant Effluents Efficiencies Range: 89% – 96%			

Disposal Points of Alexandria Wastewater Treatment Plants

The Main drains disposing treated wastewater into Maryout lake (Dr. Helaly A. Helaly)

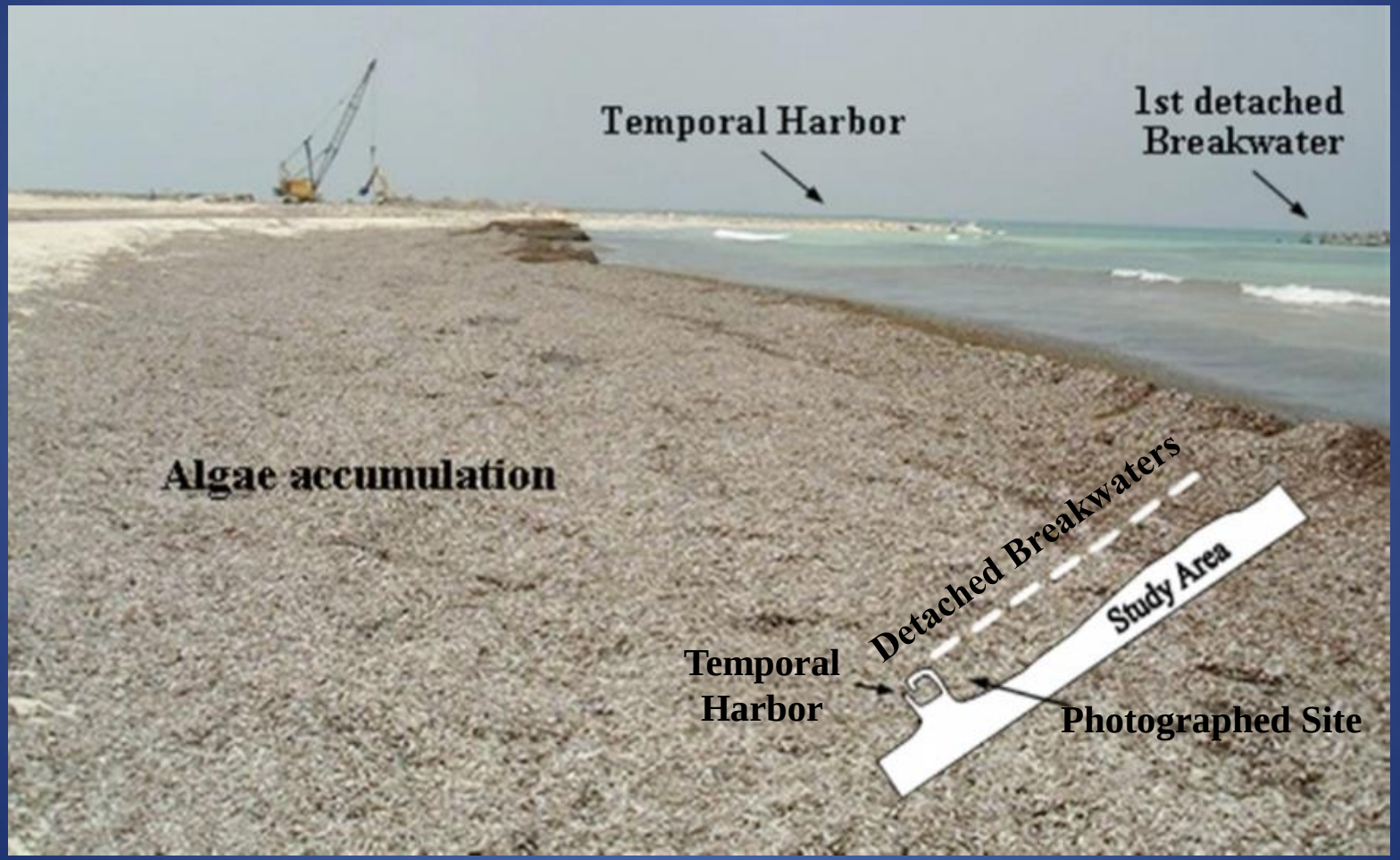
- El Qalaa Drain which receives the effluent of ETP.
- West Noubaria and El Omoum drain dispose into the Mediterranean through Lake Maryout.



Satellite Image (2015) of coastal currents along Alexandria Egypt

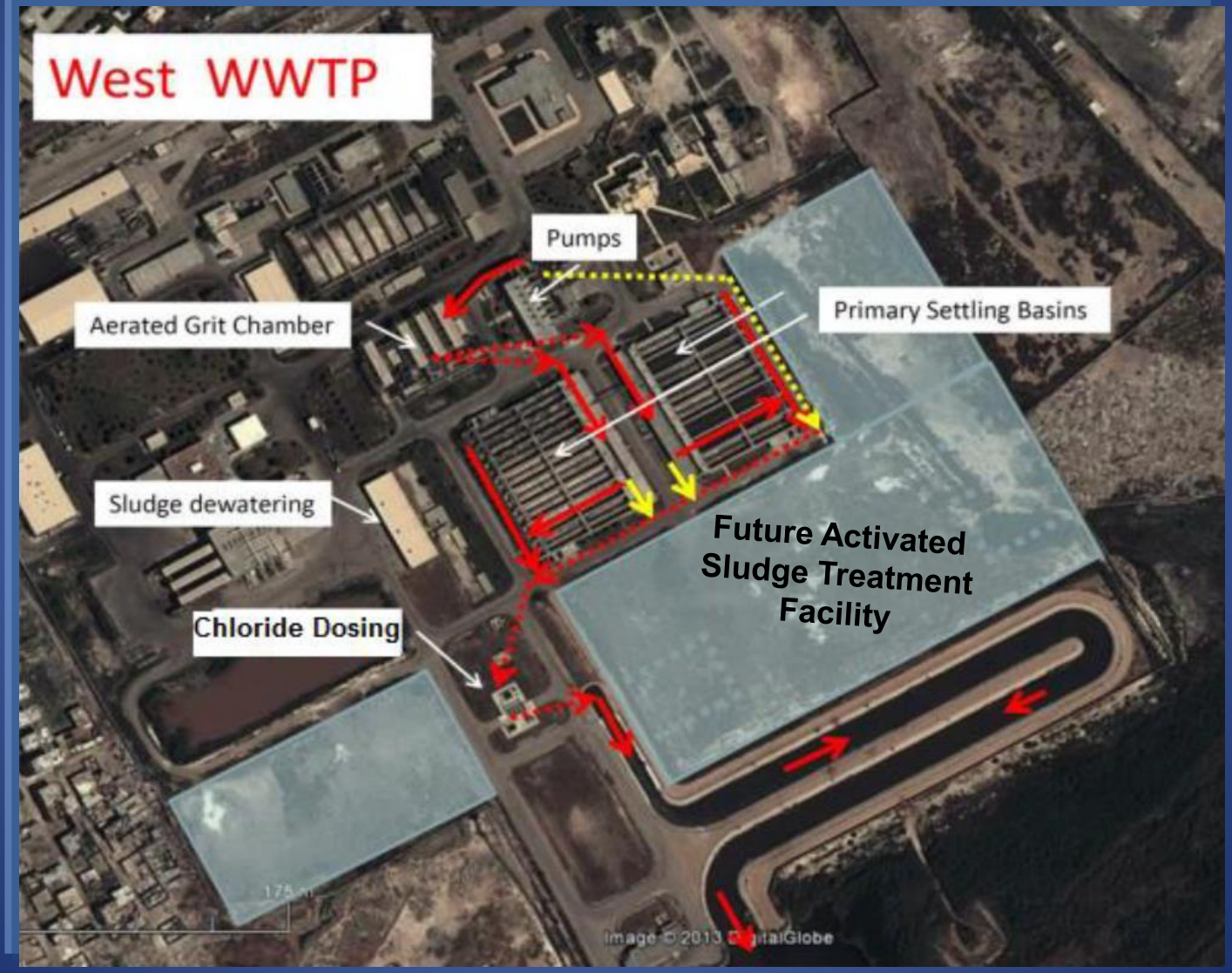
Discharge of Secondary Treated Wastewater into the Mediterranean, via Agricultural Drain

Accumulation of Benthic Algae, Leeside of the Detached Breakwaters during Summer



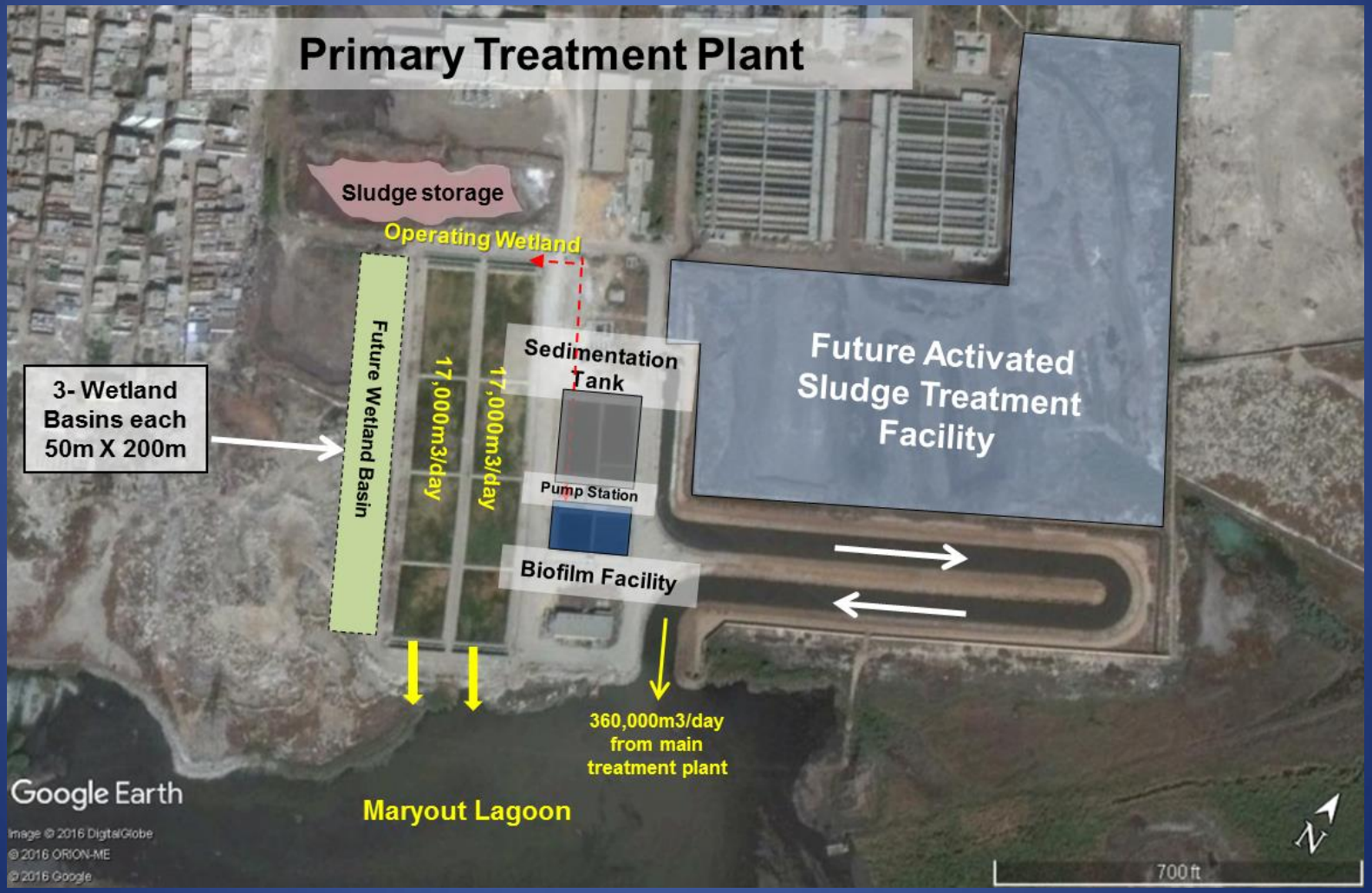
Location of Pilot Wetland at Western Plant for Wastewater Treatment, Maryout Lagoon /Lake

Western Treatment Plant Before Construction of Alexandria Pilot Wetland (2015/2016)



Photos of Integrated Treatment Pilot Wetland (a) Submerged Aerated Biofilm, (b) Sedimentation Tank and (c) Wetland, Alexandria

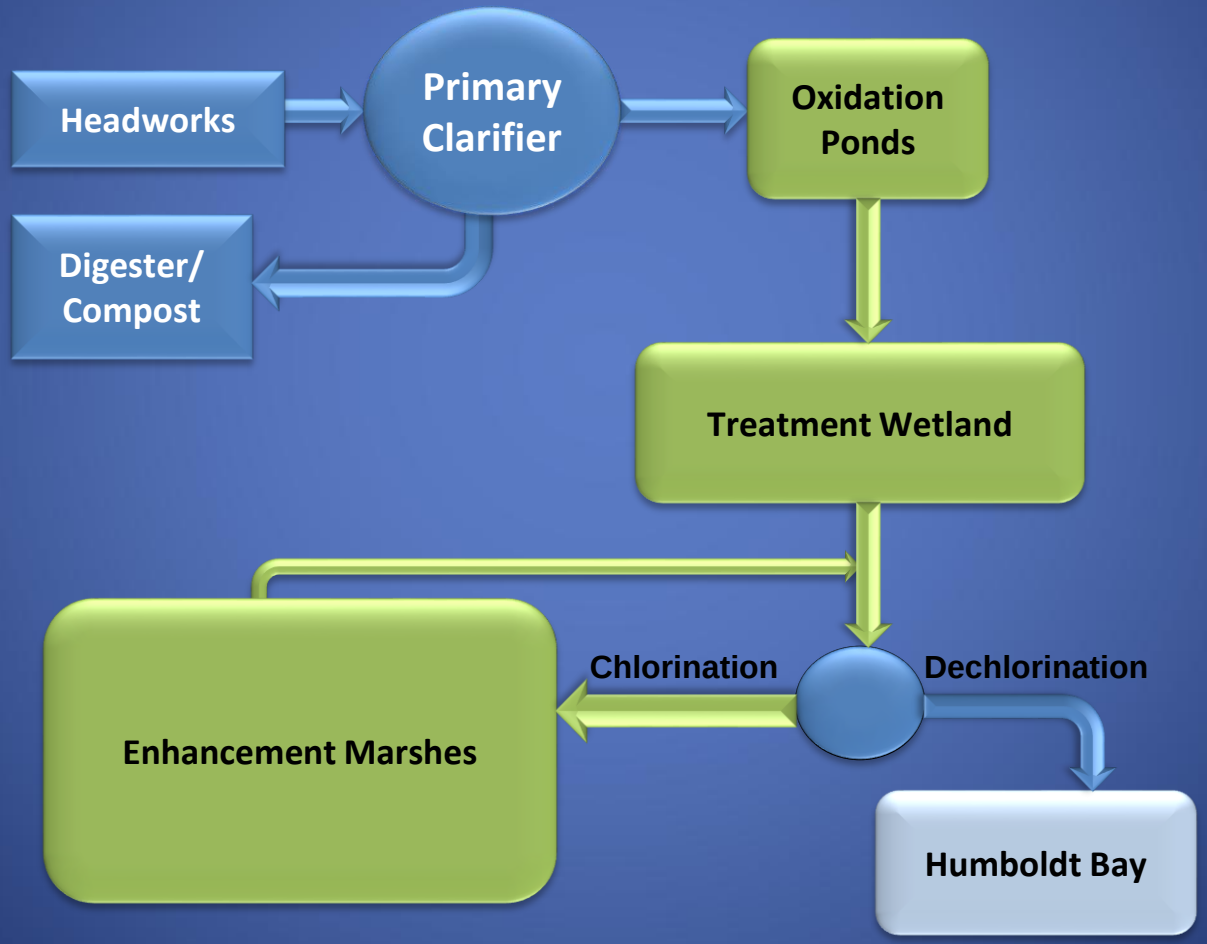
Satellite Image of the Wetland, Bio film facility and Sedimentation Tank at the Western Treatment Plant, Alexandria



Sample Record from Start-Up Monitoring Program, Alexandria Wetland, December 2016

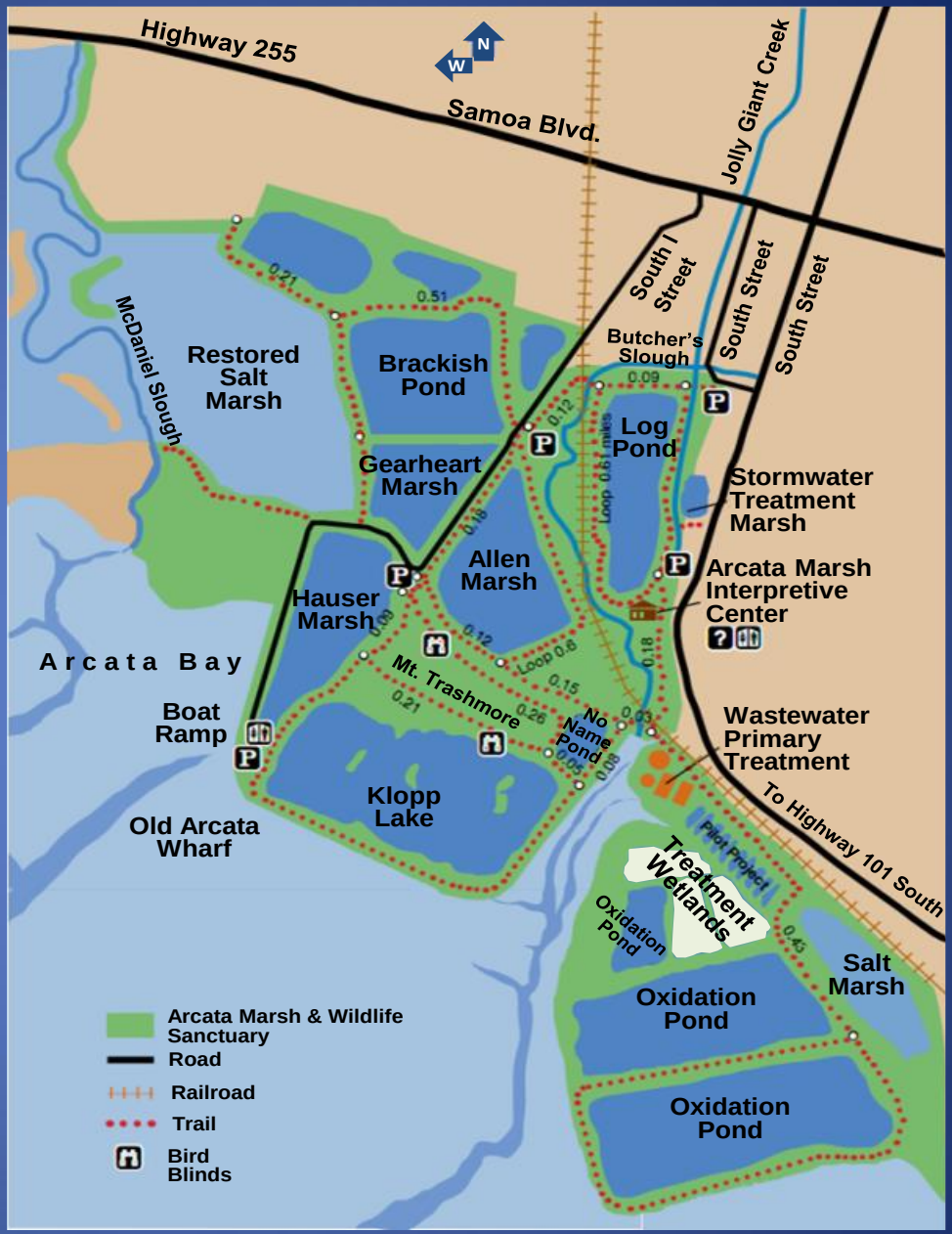
Parameter (mg/l)	Effluent from West Treatment Plant	Influent to Biofilm		Effluent from SAF to Wetland	Effluent from Wetland
N	19	20		15	10
NH4	14.6	16		14	4.8
P	3.76	3.9		3.7	3.5
BOD	162	180		46	32
TSS	117	130		52	26

Treatment Processes at the Arcata Wastewater Treatment Plant, CA.



Arcata Natural Treatment Plant , Arcata Bay, CA

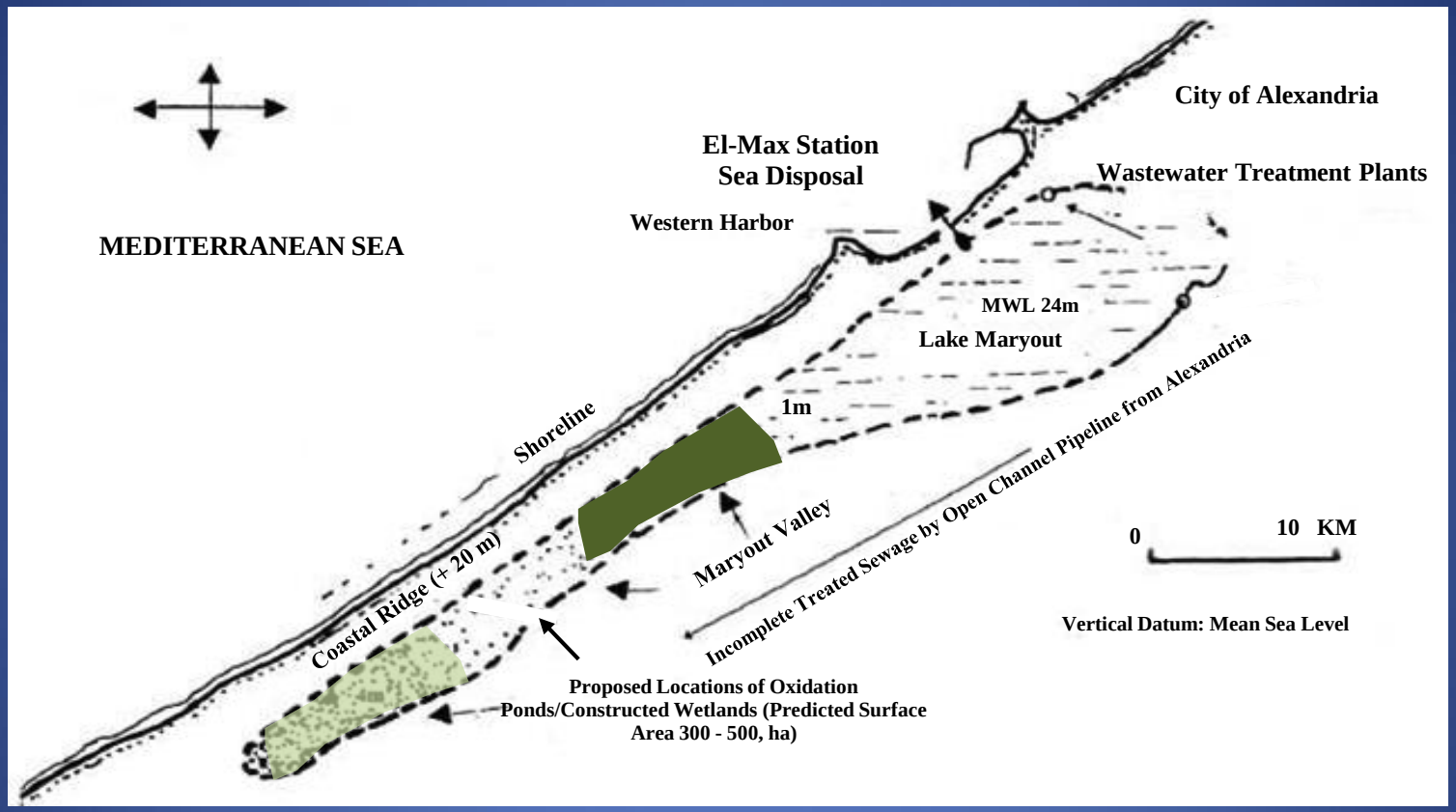
1. Primary Treatment Tanks
2. Oxidation Ponds 50.0 acres
3. Treatment Wetlands 7.5 acres
4. Enhancement Wetlands 31.0 acres



Effluent Limits for Discharge to Humboldt Bay "A", and from Wetlands to Arcata Marsh and Wildlife Sanctuary "B", EPA 2012/1993

Constituent	Units	Monthly Average		Weekly Average		Daily Maximum	
		A	B	A	B	A	B
BOD5	mg/L	30	30	45	30	60	60
Suspended Solids	mg/L	30	30	5	45	60	60
Settleable Solids	ml/L	0.1	0.1	-	-	0.2	0.2
Total Coliform	MPN/100ml	14	23	-	-	43	230
pH	S U	Not less than 6 nor greater than 9					

Location of Proposed Project Site for Natural Wastewater Treatment: West of Alexandria and New Areas for Urban Development



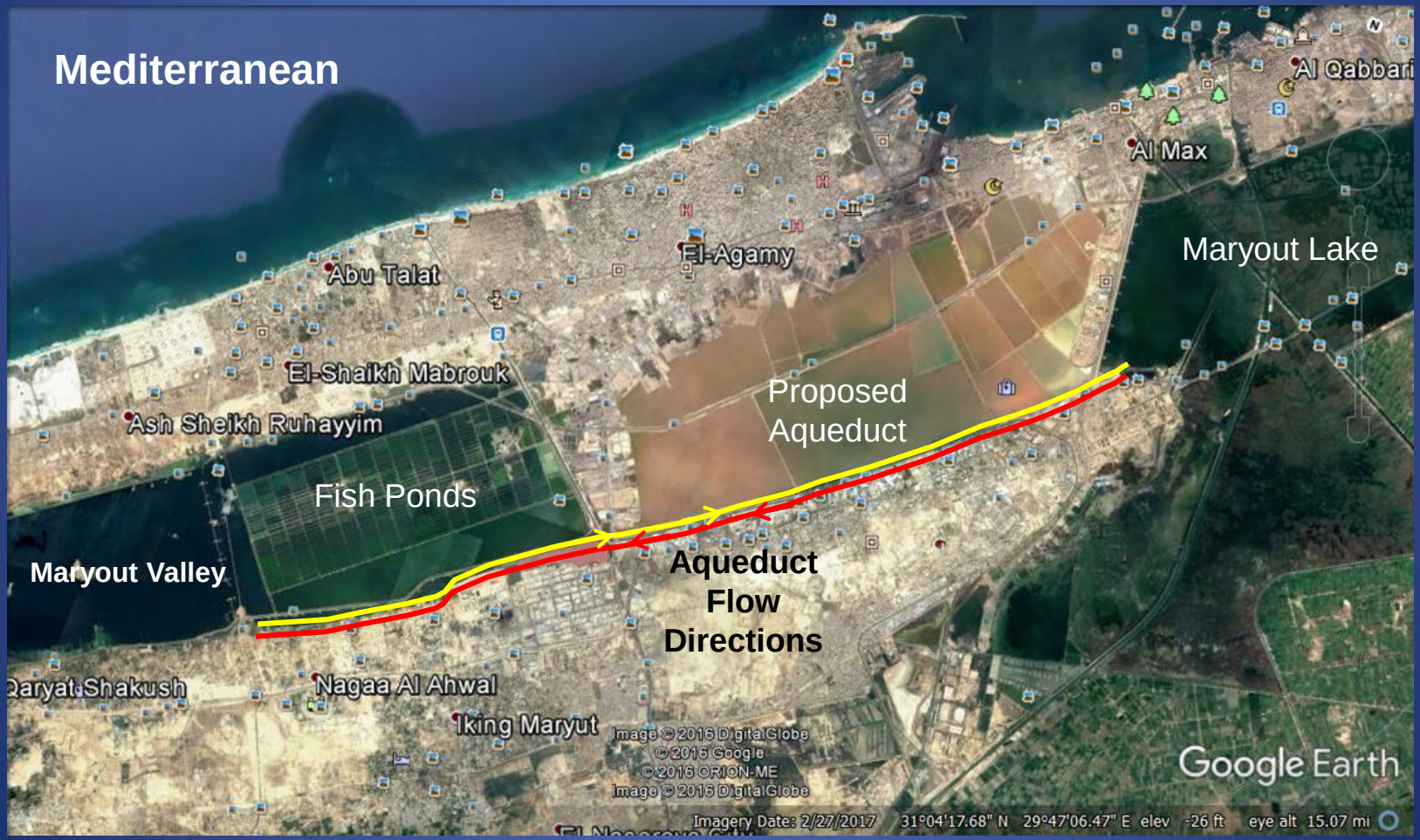
Management of Wastewater Disposal and Reuse in Coastal Areas

Nabil Ismail, Ph.D., M.ASCE

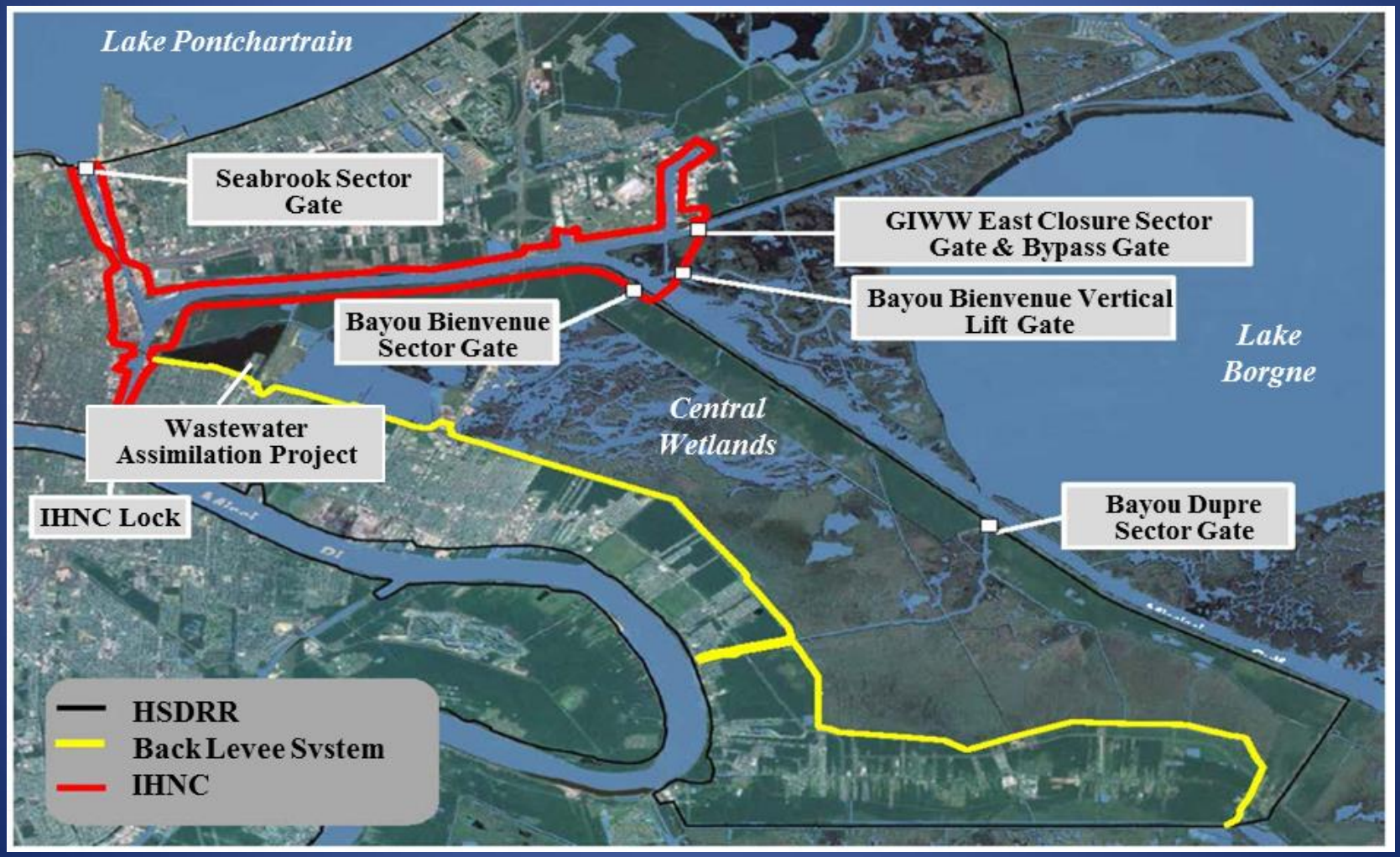
ASCE -Joint Conference on Water Resource Engineering and Water Resources Planning and Management 2000

July 30-August 2, 2000 | Minneapolis, Minnesota, United States

Proposed Water Exchange between Lake Maryout and Maryout Valley



Location of Wastewater Sludge Projects for Restoration of Natural Central Wetlands, Louisiana, USA *(Williams and Ismail, 2015)*



Use of Wastewater Bio Bolids for Wetland Rehabihitation, Central Wetlands Assimilation – Demonstration (PO-73), LA, USA

Funding: Coastal Impact Assistance Program (CIAP)

Project Purpose:

- The project will restore approximately 17 acres of critical wetlands using wetland assimilation of wastewater effluent and beneficial use of biosolids from the EBSTP. It will also provide scientific basis for future disinfection of effluent in the Central Wetlands.

Project Features:

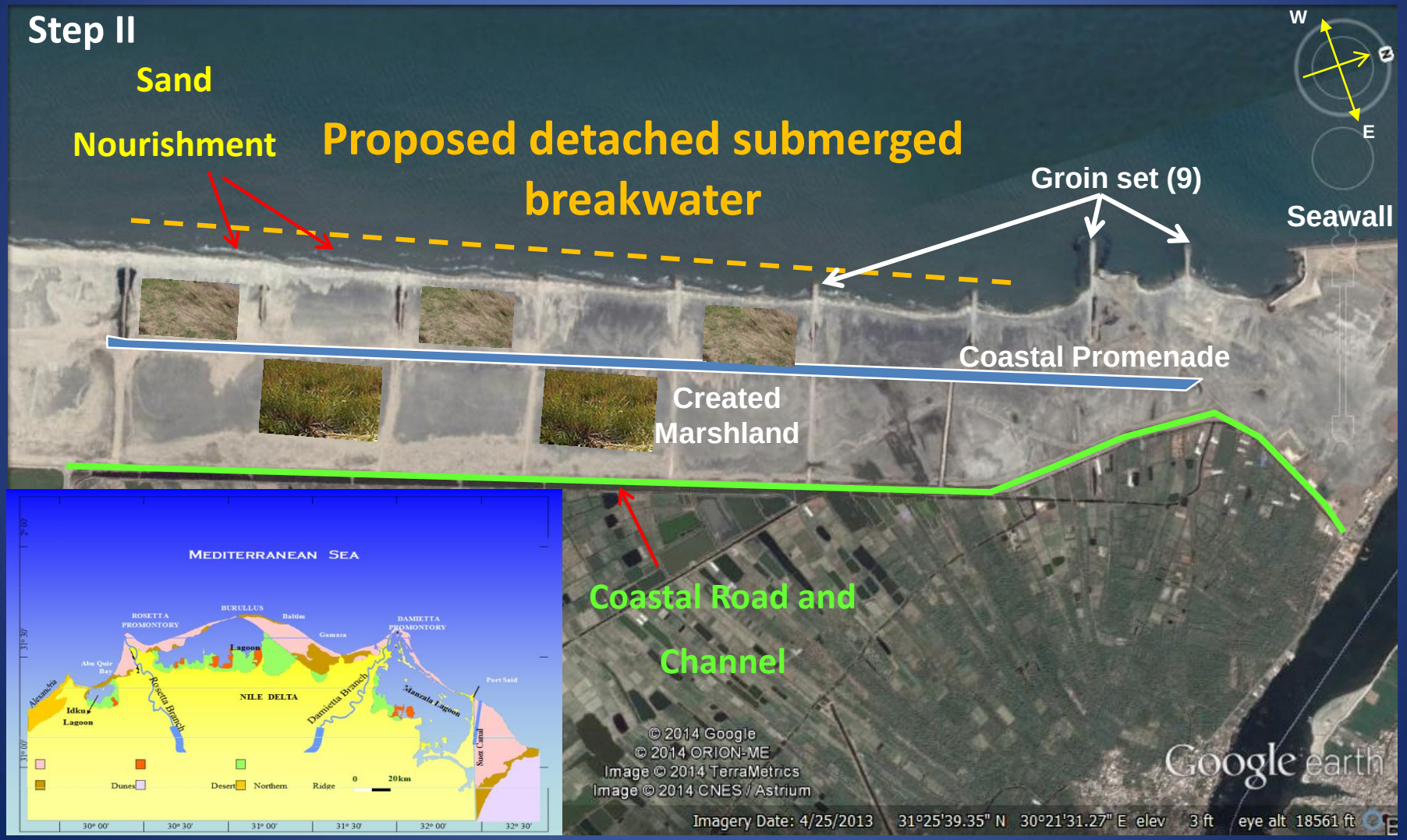
- Using ferrate, determine the impact of treating effluent and biosolids in two 8.5 acre cells
- Plant native species to help preserve wetlands

Total Project Cost: $3.5M

Status:

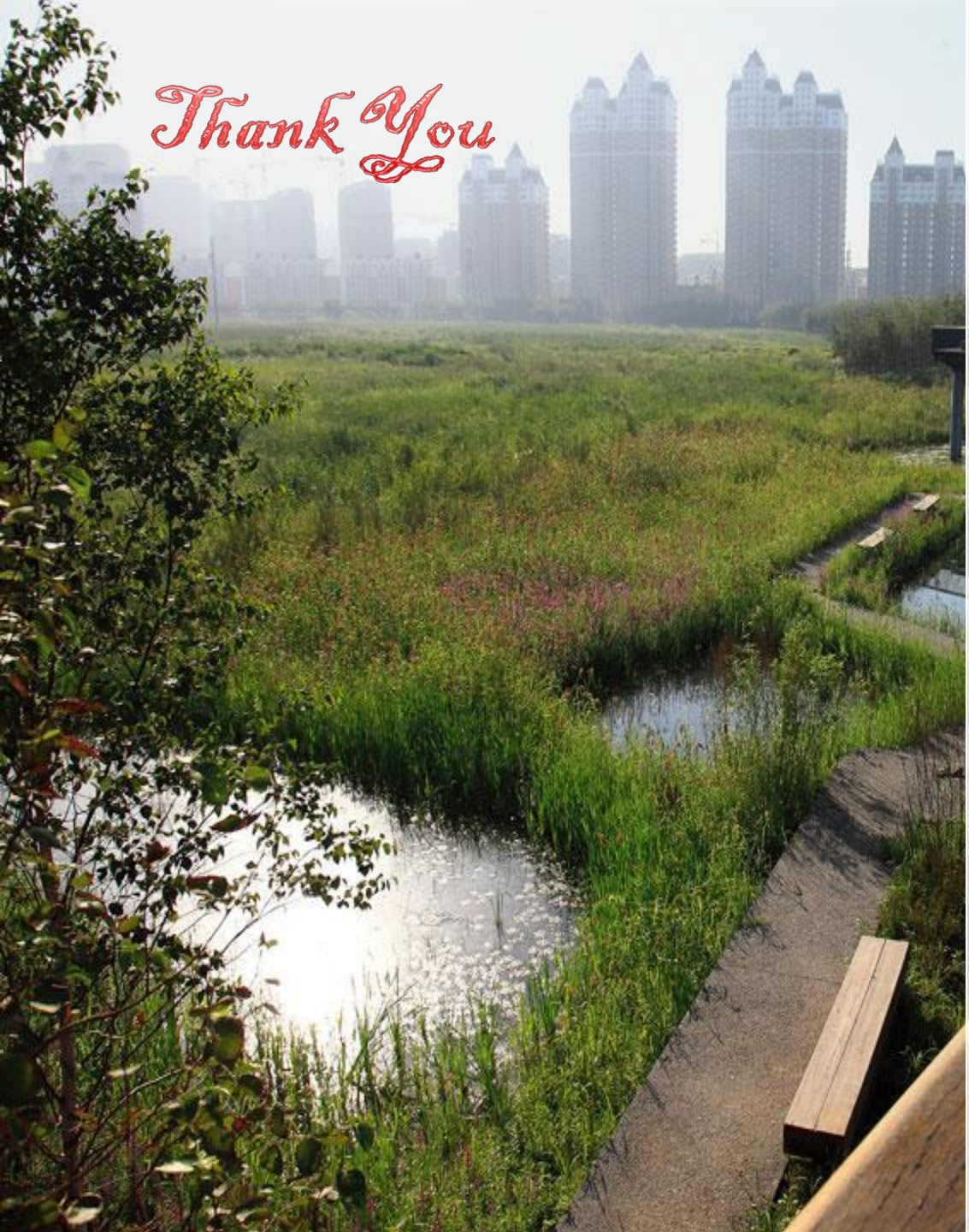
- November 2013 / 2014 to begin constriction
- Testing discharges in two cells

Planned Coastal Design For Future Urban Development – Delta Conference II, Rotteradam, Sept. 2014



Conclusions & Recommendations

- This work reinforces the fact that constructed wetland (CSW) system holds great promise for enabling high rate removal of phosphorus, nitrogen and organic matter from domestic wastewater.
- Startup data for the Alexandria integrated Pilot Wetland indicate that the system is capable to upgrade the primary treatment wastewater to an acceptable level for safe discharge into coastal waters. Such amount of upgraded treated water is equivalent to more than 2.0 percent of the current disposed primary treated water into Lake Maryout.
- Highlights are presented on potential use of wastewater bio-solids for restoration of constructed and natural wetland, which serve as coastal defense system; e.g. at the Nile Rosetta headland, San Francisco Bay, and the Central Wetlands in Louisiana, USA.



"Make no little plans: they have no magic to stir men's blood and probably themselves will not be realized. Make big plans; aim high in hope and work, remembering that a noble, logical diagram once recorded will never die, but long after we are gone will be a living thing, asserting itself with ever growing insistency. Remember that our sons and daughters are going to do things that would stagger us. Let your watchword be order and your beacon beauty."

- Daniel Hudson Burnham (1846-1912)

Architect for the 1893 World's Columbian Exposition held at Chicago and lead author of the 1909 Plan of Chicago, USA.