Development of Freshwater Inflow Diversion Estimates for Hydrologic Restoration of the Naples Bay and Rookery Bay Watersheds, Southwest Florida
Collier County in Southwest Florida
Homeowners like dry houses
Ranchers and farmers like healthy cows

Healthy

Not healthy
How cows get foot rot
One way to solve both problems
In Southwest Florida, highly altered watersheds, habitat and ecological systems

Extensive canal network

Numerous water control structures
Rookery Bay watershed highly modified, and reduced by ca. 80 sq. miles

From Interflow Engineering Inc. and Taylor Engineering (2014)
Greater Naples Bay watershed increased 10-fold (ca. 120 square miles)

Historical watershed
Consensus on impacts to watersheds and coastal waters from altered hydrology

- Impacts to ecology of Naples Bay
  - (e.g., SFWMD 2007, Atkins 2011, Cardno 2015, and others)

- Impacts to ecology of Rookery Bay watershed
  - (e.g., Parsons, 2006, SFWMD and USACE 2010, Atkins 2011, RBNERR 2012, and others)

- Impacts to ecology of Rookery Bay
  - (e.g., Shirley et al. 2004, 2005, Rubec et al. 2006, Atkins 2011, and others)
So, how about retrofitting watersheds?

- Golden Gate Water Management Plan (Johnson Engineering for SFWMD-BCB, 1980)
- Big Cypress Basin Water Management Plan, 1998
- SWIM Plan for Naples Bay (SFWMD 2007)
- Collier County Watershed Management Plan (Atkins 2011)
- Naples Bay Water Quality and Biological Analysis Project (Cardno 2015)

Image from “Naples Bay 20 Year Plan” (City of Naples)
However...

- While Rookery Bay has a wet weather inflow deficit, Henderson Creek does not (Interflow Engineering Inc. and Taylor Engineering, Inc. 2014)

- Water quality in Golden Gate Canal (GGC) has higher nitrogen and phosphorus content than runoff from Rookery Bay’s watershed

- A Naples Bay water bypass via Henderson Creek would not rehydrate the Rookery Bay watershed or provide water quality improvements for the diverted water.
Proposed project

- Divert flows out of GGC when sufficient water to avoid upstream water user impacts
- Spreader canal to increase area of Rookery Bay watershed receiving water
- Protective of threshold for excess inflows to Rookery Bay
- Avoid impacts to listed species in the Rookery Bay watershed
Project constraints

- Wet season inflow deficit of 50 cfs in Rookery Bay
- Estimate that 50% of added flows would not make it to Rookery Bay
  - Evapotranspiration
  - Infiltration
  - Dispersed wet season storage
- Maximum diversion of 100 cfs only when sufficient water levels reached in GGC
- Need to keep wetland vegetation within envelope for hydroperiod and water depths for listed species
Diversions on approximately 11% of days

Those days represent 43% of inflow to Naples Bay

When operating, reduction of inflow rates by 13 to 26%
  - Average of 16% reduction of inflows when operating
  - Average of 7% reduction in annual average inflows

Average of 2.7 B gals per year or 8,300 acre-feet

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Pumping Days</th>
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<tr>
<td>2009</td>
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<td>40</td>
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<td>18</td>
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<tr>
<td>2014</td>
<td>33</td>
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<td>Average</td>
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Projects features
Preliminary Model Results - Hydroperiod (2009 - 2014)

- Largest increases in the center of forest
- Minimal impacts outside of forest
- No impacts to RCW habitat
- Minimal changes to vegetation communities
Preliminary Model Results - Average Depths (2009 - 2014)

- Average depth increases are less than 1-inch in hydric and mesic flatwood areas
- Minimal impacts outside of forest
- No impacts to RCW habitat
- Minimal changes to vegetation communities
Estimating benefits

► Naples Bay
  ► Changes in salinity regimes create positive conditions for habitat development
  ► Expected water quality benefits associated with nutrient load reductions

► Rookery Bay watershed
  ► Increase water depth and hydro-periods to previously impacted wetlands, without altering species composition
  ► Benefit to ca. 10,000 acres of mostly cypress and hydric flatwoods

► Rookery Bay
  ► Restore freshwater inflows from forest to Rookery Bay
  ► Sufficient combination of water storage and sheet flow to maintain water quality of current watershed
Predicting salinity changes with and without diversions
Naples Bay - area benefited is ca. 400 acres

- Expectation of 20% difference in salinity and an average salinity difference of 2 ppt or higher

- Sets the stage for future seagrass and oyster bed restoration

After diversions implemented, potential locations to “jump start” restoration via seagrass transplanting and oyster reef deployment
Naples Bay - Reductions in nutrient loads

- Equivalent to 3,000 20-lb bags of lawn fertilizer per year
- Additional benefits to water clarity expected due to reduction in turbidity
Project Area A

- Project Components
  - Extensive created wetland system
  - Required for water quality treatment
Project Area A

- **Project Components**
  - 110-foot wide flowway
  - Planted with wetland islands for habitat and water quality improvements
How much of a nutrient load from GGC would be delivered to Rookery Bay?

- **Two step process**
  - Hunter et al. (2009)
    - Relationship between removal efficiency of nutrient reduction and area-normalized nutrient loads (grams / m$^2$ / yr)
    - Applied only to Northern Flow-way (5,000 foot length, north of I-75)
    - Output becomes input to rest of the flowpath
  - Rudnick et al. (1999)
    - Based on transect work in eastern Everglades
    - Further reductions anticipated after water exits Northern Flow-way
Expected load reductions

- **Combined** -
  - 89 % reduction in TN loads
  - 77 % reduction in TP loads

- Nutrient loads diverted from Naples Bay do not equal pound for pound nutrient loads entering Rookery Bay (or even Rookery Bay watershed)
Adaptive Management

- Built-in capacity to change hydrologic loading
- Hydrologic, wetland and habitat monitoring
- Diverted flows can be decreased if needed or system capacity could be increased
Project Development and Estimated Cost

- Project conceptual plan set (~15% design level and includes a 25% contingency)
  - Project Area A (Northern Flowway) 6M
  - Project Area B (I-75 Canals Plan) 2M
  - Project Area C (South Belle Meade) 4.8M
  - Project Area D (Sabal Palm Rd.) 0.2M
  - Project Area E (Six L’s/US 41 Plan) 9M

- Minor projects 1M
  - Project Development & Design 4M
  - Monitoring 1M
  - Permitting & Mitigation 3M

(Phase II) North Belle Meade Flowway
  - Preliminary Engineering 1M

(Phase II) Six L’s Masterplan 1M

TOTAL 33M
Questions?