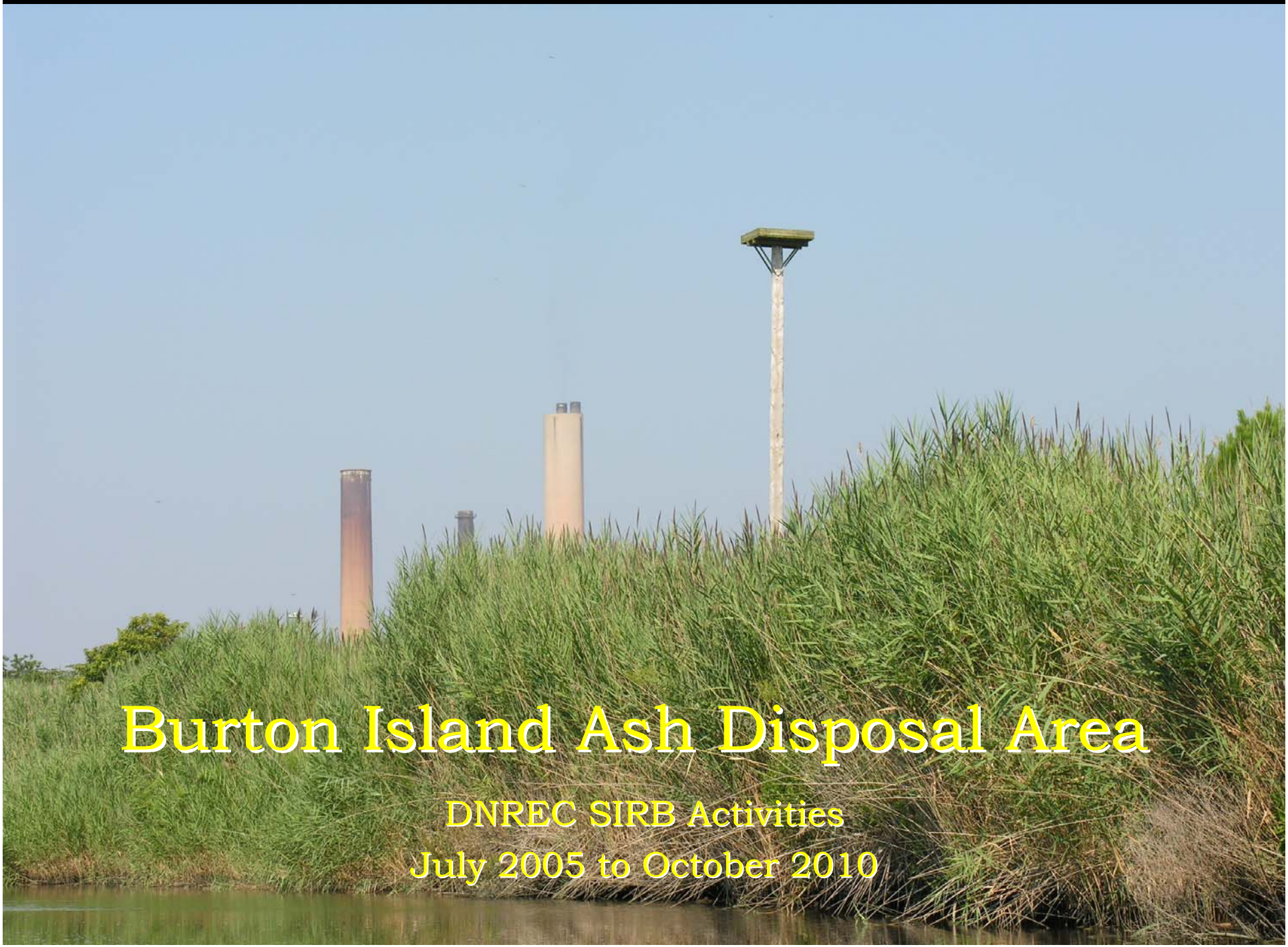


Burton Island Ash Disposal Area

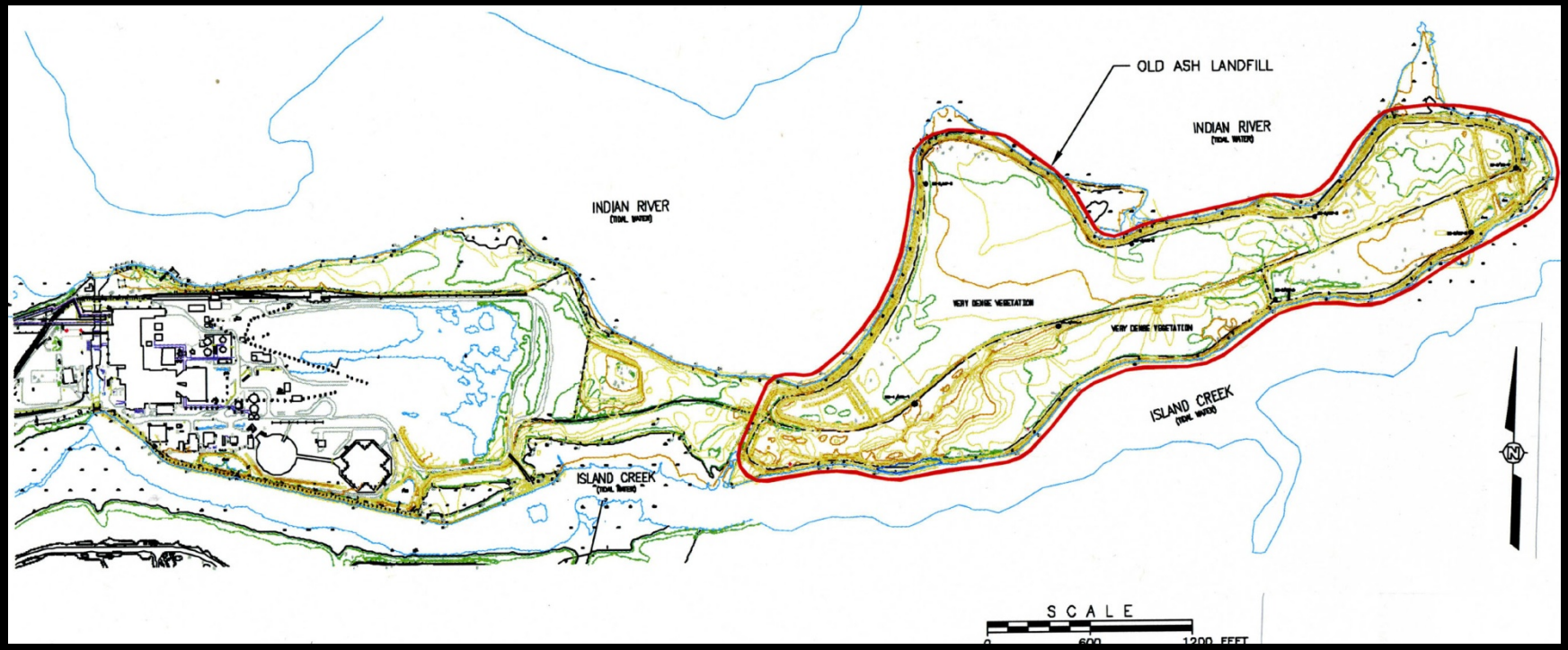
DNREC SIRB Activities

July 2005 to October 2010

Compiled by Greg DeCowsky, DNREC SIRB, Project Manager/Natural Resource Trustee for Administration

Indian River Generating Station (IRGS)

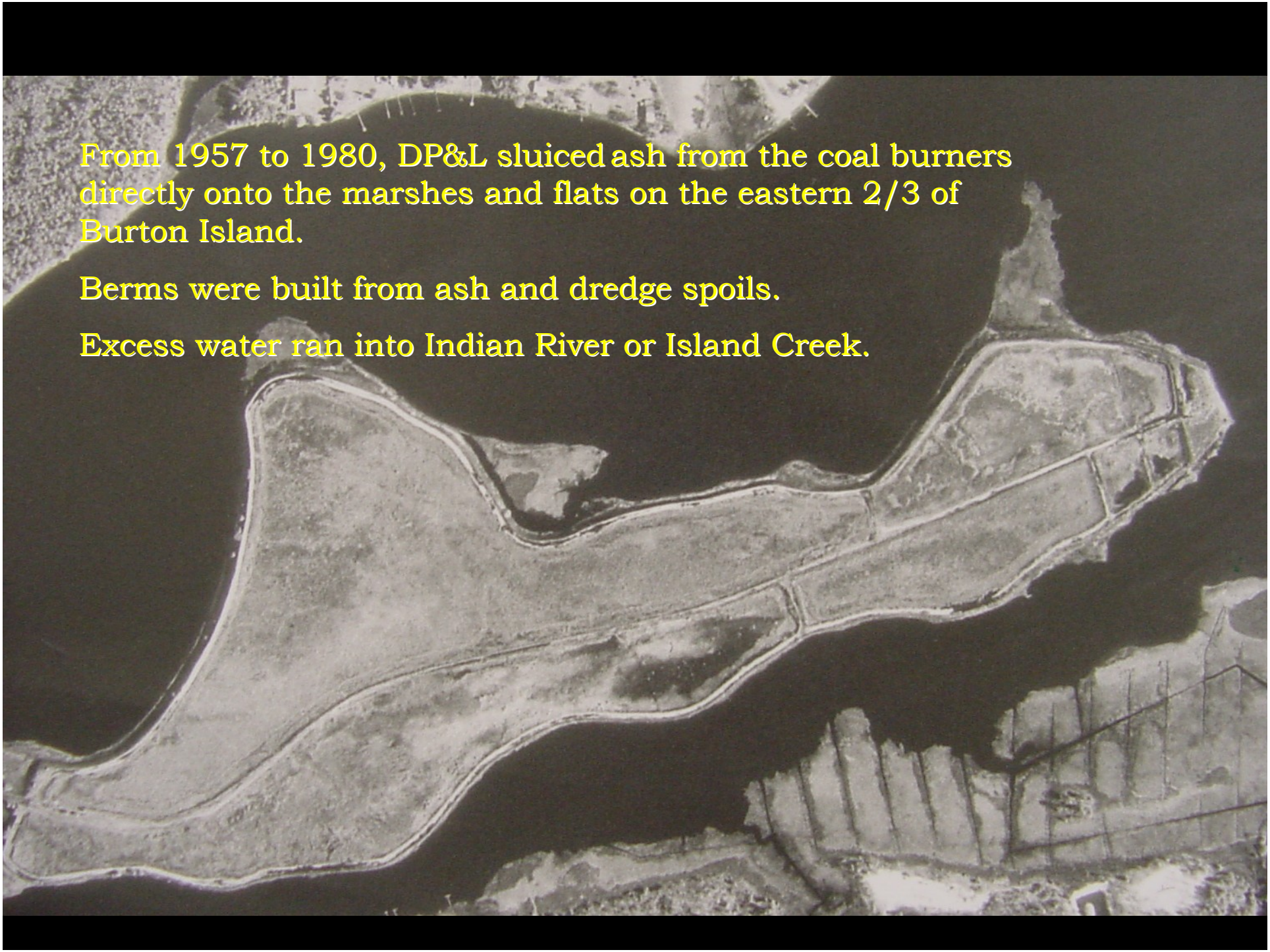
- Originally owned by Delmarva Power & Light (DP&L)
- Operational from 1957 to present
- Now four coal-fired units (and one small oil-fired unit)
- Three “dirtiest” coal units slated to close in 2013; fourth to receive air pollution control upgrades
- Sold to NRG subsidiary Indian River Power LLC in 2001
- NRG took liability for all environmental matters except an underground fuel oil release (first identified in 1999 and still the subject of remediation and NRDA).



Site Layout: Power plant to left (west), old coal ash disposal area to right (east), outlined in red. *(Drawing by Shaw Environmental.)*


9
WILDLIFE
10
Burton Island, 1937

Burton Island, 1954

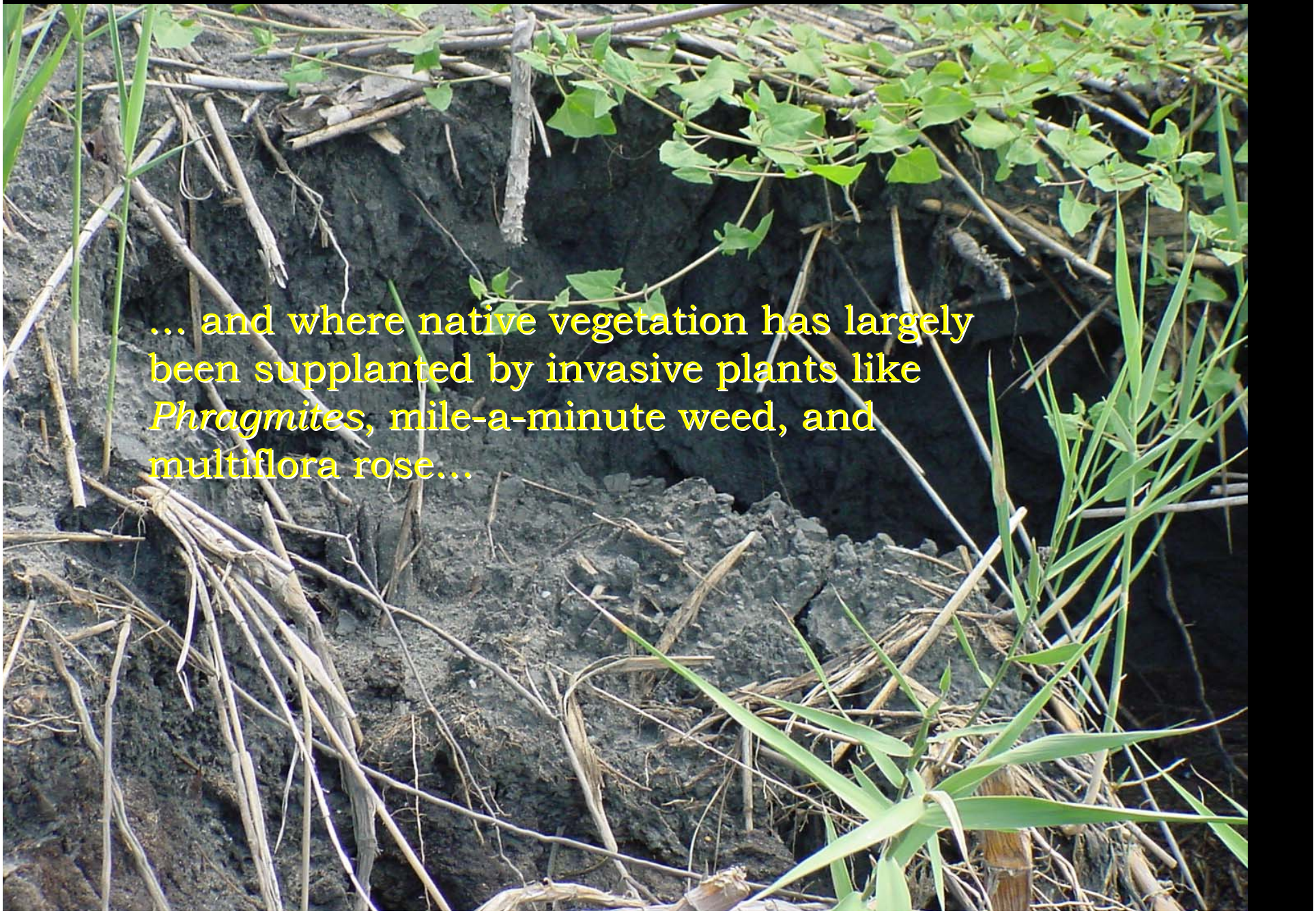

From 1957 to 1980, DP&L sluiced ash from the coal burners directly onto the marshes and flats on the eastern 2/3 of Burton Island.
Berms were built from ash and dredge spoils.
Excess water ran into Indian River or Island Creek.

- Before 1974, the General Assembly had not authorized DNREC (founded in 1970) or its predecessors to regulate coal ash disposal.

- DNREC Water Resources Section issued a Solid Waste Approval to DP&L in 1980 for disposal of "inert boiler ashes and inert construction debris."


The disposal resulted in the elevation of the ground surface by about 15± feet over most of the island, and the wholesale conversion of tidal marshes and flats to upland…


… where the “soil” is coal ash containing heavy metals…

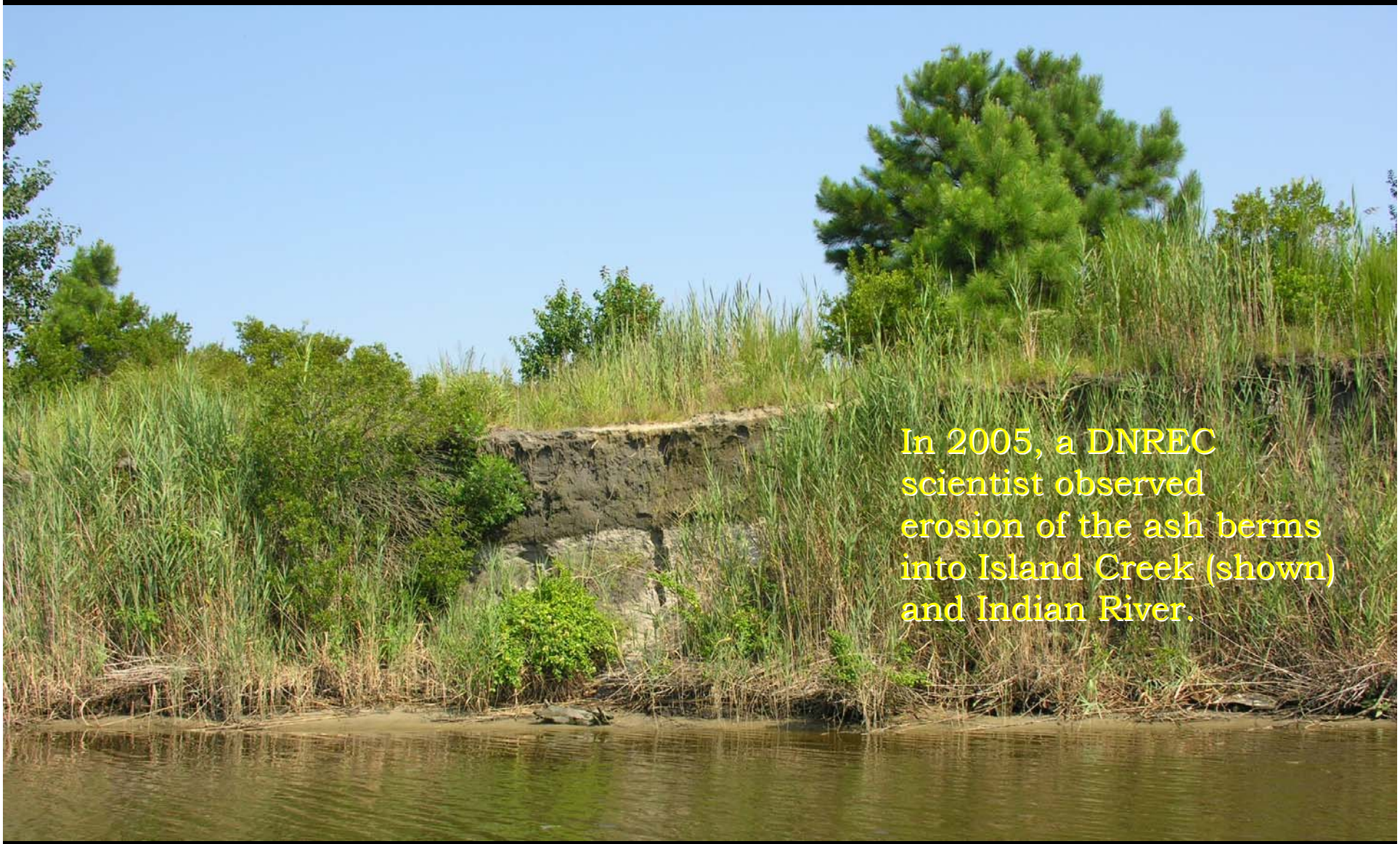

... and where native vegetation has largely been supplanted by invasive plants like *Phragmites*, mile-a-minute weed, and multiflora rose...

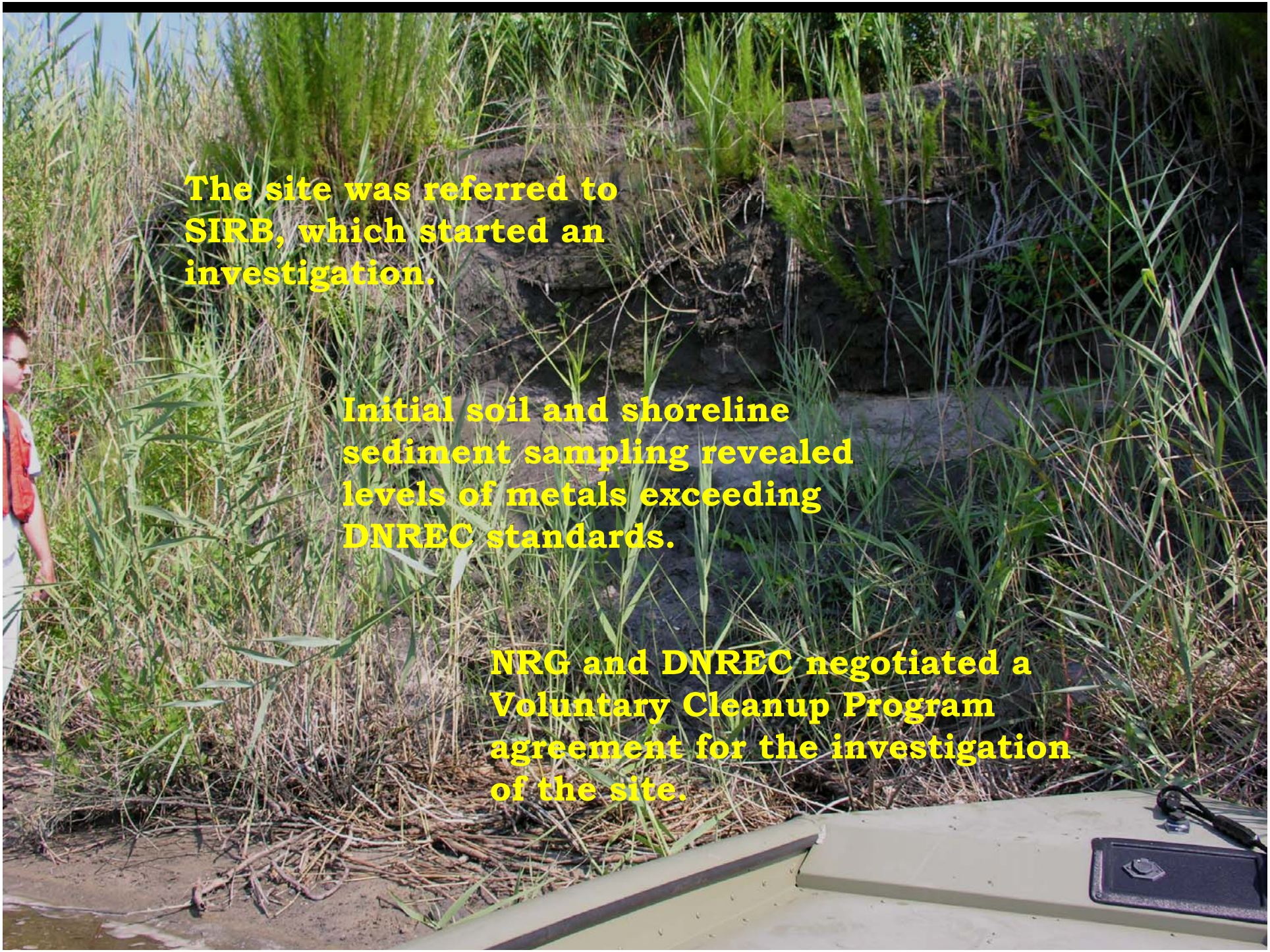

... though the native salt marsh cordgrass (Spartina alterniflora) still survives in fringing wetlands around much of the island and on several spits on the river side.

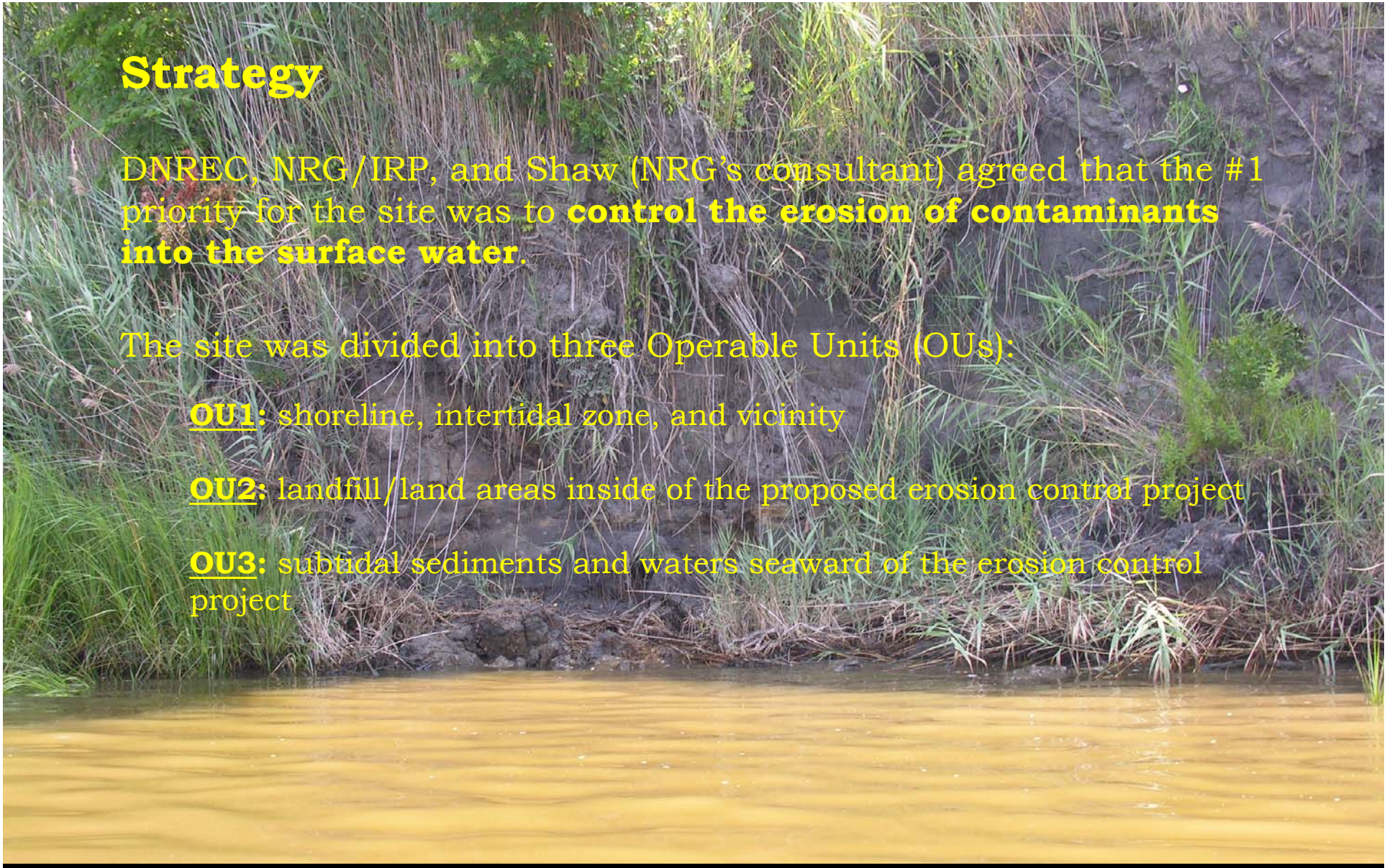
In 1980, DP&L opened a new "Phase I" landfill, on the mainland south of Island Creek, with a permit from the DNREC Solid and Hazardous Waste Management Branch (SHWMB).

The unpermitted Burton Island ash dump ceased operation, but was left in place.

NRG has constructed a new "Phase II" landfill. Cell 1 received SHWMB approval to operate on 9/17/10. It replaces Phase I, which is now being capped with an impermeable membrane.


In 2005, a DNREC scientist observed erosion of the ash berms into Island Creek (shown) and Indian River.


The site was referred to SIRB, which started an investigation.
Initial soil and shoreline sediment sampling revealed levels of metals exceeding DNREC standards.
NRG and DNREC negotiated a Voluntary Cleanup Program agreement for the investigation of the site.



Strategy

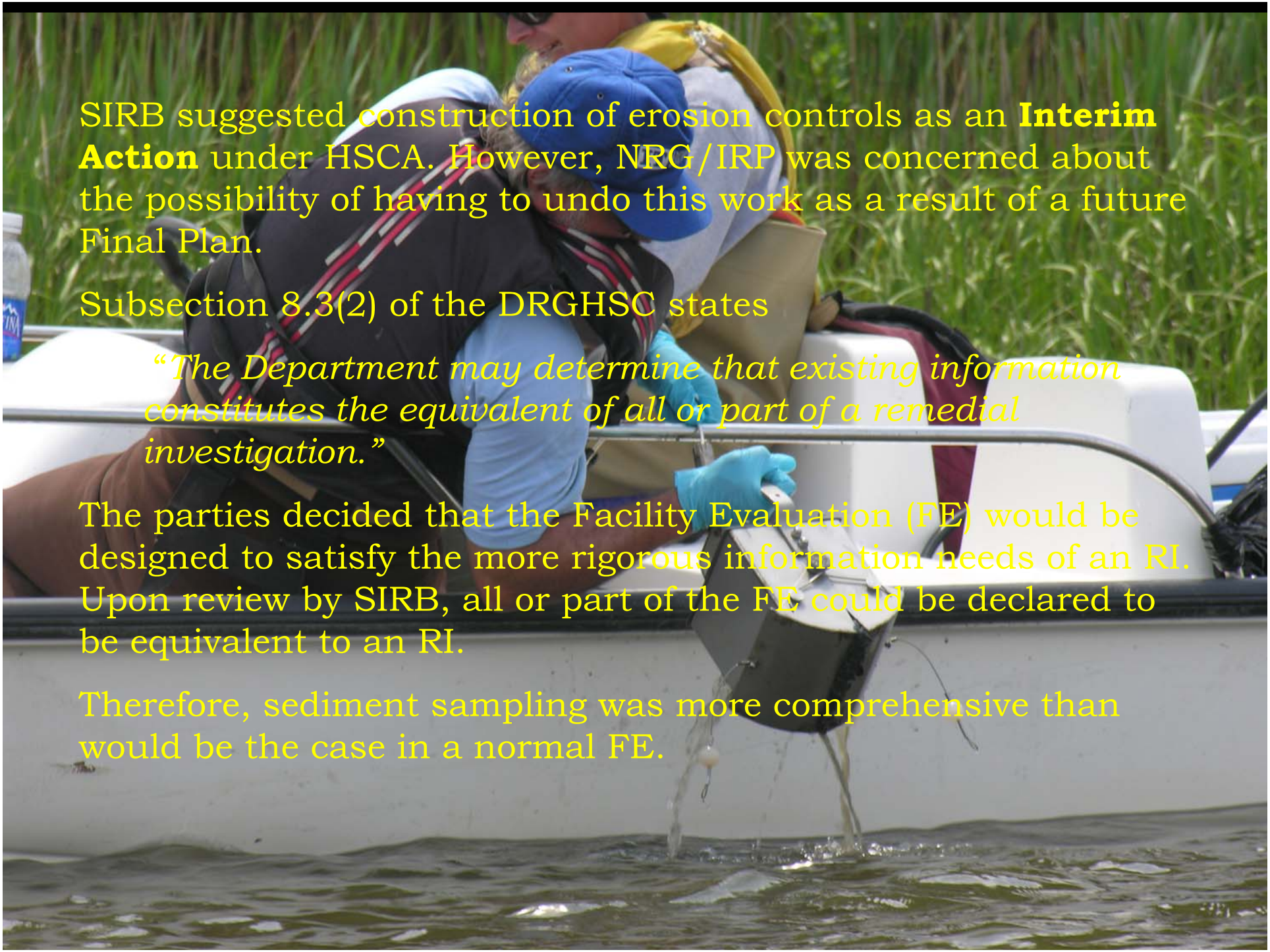
DNREC, NRG/IRP, and Shaw (NRG's consultant) agreed that the #1 priority for the site was to **control the erosion of contaminants into the surface water**.

The site was divided into three Operable Units (OUs):

OU1: shoreline, intertidal zone, and vicinity

OU2: landfill/land areas inside of the proposed erosion control project

OU3: subtidal sediments and waters seaward of the erosion control project



SIRB suggested construction of erosion controls as an **Interim Action** under HSCA. However, NRG/IRP was concerned about the possibility of having to undo this work as a result of a future Final Plan.

Subsection 8.3(2) of the DRGHSC states

> *"The Department may determine that existing information constitutes the equivalent of all or part of a remedial investigation."*

The parties decided that the Facility Evaluation (FE) would be designed to satisfy the more rigorous information needs of an RI. Upon review by SIRB, all or part of the FE could be declared to be equivalent to an RI.

Therefore, sediment sampling was more comprehensive than would be the case in a normal FE.

Upon review of the FE report, SIRB found that for OUs 1 and 3, the FE was sufficient to constitute an RI, allowing a saving of a major step in the HSCA process and of at least a year's worth of erosion. A Proposed Plan was issued calling for construction of the erosion controls as the remedy for OU1 and No Further Action (based on low human health risks) for OU3.

Following a public hearing, a Secretary's Order was issued approving the Proposed Plan as written. The Final Plan was signed on August 1, 2008, and the OU1 remediation was performed by NRG's contractors during the winter and spring of 2008-2009.

Facility Evaluation

Glossary

µg/L = micrograms per liter
(Used for water; equivalent to parts per billion)

mg/kg = milligrams per kilogram
(Used for solid media; equivalent to parts per million)

MCL = Maximum Contaminant Level
The maximum permissible level of a contaminant in water delivered to any user of a public system. MCLs are enforceable standards.

PCB = Polychlorinated biphenyl

SVOC = Semivolatile organic compound
(Examples: naphthalene, benzo-a-pyrene)

VOC = Volatile organic compound
(Examples: acetone, benzene)

Arsenic

DNREC Default Background Standard for soil

11 mg/kg

Arsenic

DNREC Uniform Risk-based Standards (URS)

For protection of **human health** (URS-HH):

Ground Water (for screening purposes)

0.50 µg/L

(EPA MCL = 10 µg/L)

For protection of the **environment** (URS-ENV):

Surface Water

3 µg/L

Sediment

8 mg/kg

Surface Soil

10 mg/kg

Operable Unit 1

Shoreline sediments

26 samples collected from the top 6″:

- No organic chemical contaminants (VOCs, SVOCs, Pesticides, or PCBs) detected in DNREC screening or in confirmatory samples sent to a commercial lab.
- 21 metals detected, including 9 identified as preliminary Constituents of Potential Concern (COPCs) for either human or ecological receptors.

Constituents of Concern

following risk assessments

OU1 [Shoreline] Sediments

Arsenic (26 of 26 samples, 1.6 to 160 mg/kg)

Barium (26 of 26 samples, 1.9 to 163 mg/kg)

Selenium (7 of 26 samples, 1.2 to 4.9 mg/kg)

Operable Unit 3

Offshore sediments and waters

26 offshore sediment samples collected (20′ offshore from each of the 26 intertidal zone [OU1] samples, from top 6″):

- No VOCs, SVOCs, Pesticides, or PCBs detected in screening or confirmatory samples.
- 20 metals detected, including 10 identified as preliminary COPCs.

8 surface water samples collected:

- No VOCs, SVOCs, Pesticides, or PCB's detected in screening or confirmatory samples, except for a single detection of heptachlor epoxide in a confirmatory sample.
- 16 metals were detected, including 3 identified as preliminary COPCs.

Constituents of Concern

following risk assessments

OU3 [Offshore] Sediments

Aluminum (26 of 26 samples, 1340 to 18,200 mg/kg)

Arsenic (26 of 26 samples, 3.2 to 37.4 mg/kg)

Barium (26 of 26 samples, 7.6 to 148 mg/kg)

Cobalt (26 of 26 samples, 0.85 to 11.8 mg/kg)

Copper (26 of 26 samples, 2.4 to 39.4 mg/kg)

Mercury (25 of 26 samples, 0.03 to 0.26 mg/kg)

Nickel (26 of 26 samples, 2.2 to 26 mg/kg)

Selenium (7 of 26 samples, 1.9 to 3.4 mg/kg)

Constituents of Concern

following risk assessments

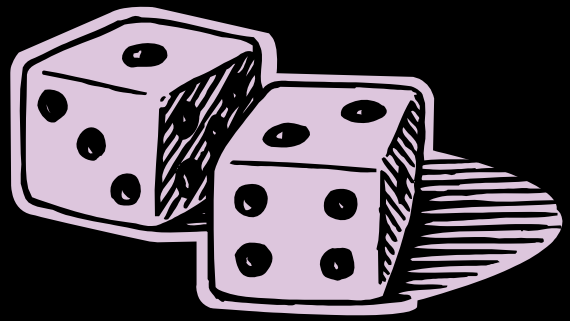
OU3 [Offshore] Surface Waters

Arsenic (5 of 8 samples, 3.2 to 14.4 µg/L)

Barium (8 of 8 samples, 44 to 73.4 µg/L)

Nickel (4 of 8 samples, 2.9 to 5.8 µg/L)

Assessing the potential risks posed by OU1 and OU3



- A **Human Health** Risk Assessment (HHRA) and a Screening-Level **Ecological** Risk Assessment (SLERA) were performed for the site by Shaw as part of the FE.
- The HHRA was reviewed by SIRB.
- The SLERA was reviewed by SIRB's consultant, the Louis Berger Group.

Human Health Risk Assessment (HHRA)

How is health risk assessed?

- Based on extremely conservative assumptions ("Err on the side of caution.")
- Uses multipliers to account for uncertainties
- Separately for cancer and non-cancer risks
- Calculated separately for each exposure pathway, then combined
- Compared to established DNREC criteria:
  - Cancer risk less than 1 case in 100,000 adults (1×10^{-5}) meeting the exposure assumptions
  - "Hazard Index" less than 1 for non-cancer risks
- Reviewed for reasonableness in light of uncertainty factors and conservative assumptions.

Human Health Risk Assessment (HHRA)

Exposure Pathways for OU1 and OU3

- OU1 is private property, restricted to occasional access by plant personnel, who are protected by plant and OSHA health and safety requirements. The remedy (erosion control) will isolate the contamination from contact with people (including trespassers).
- OU3 is waters and underwater (subtidal) land, with routine exposure to contaminants only plausible for recreational anglers and those who may eat fish or shellfish caught here. (Taking of shellfish in the plant area is currently prohibited for reasons unrelated to the plant and landfill.)

Human Health Risk Assessment for OU1

Trespasser on OU1:

Risk was not quantified because there is no evidence of trespassing, and because the remedial action (shoreline stabilization) would prevent trespassers from coming in contact with contaminated OU1 sediments.

Human Health Risk Assessment for OU3

OU3 Risk Assessment **Assumptions**: Recreational Angler

- 350 days/year for 30 years
- Body weight
  - Adult: 70 kg (141 lb)
  - Child (1-6 years old): 17 kg (37 lb)
- Fish ingestion
  - Adult: 0.0175 kg/day (~13.5 lb/year)
  - Child: 0.0065 kg/day (~5 lb/year)
- 100% of the chemical is absorbed
- 100% bioavailable

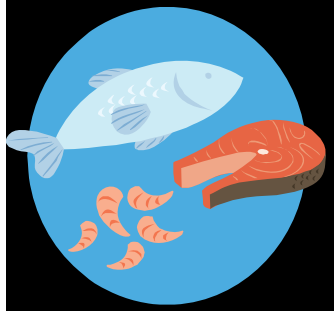
OU3:
Calculated Risks and Conclusion

Cancer risk: 5×10^{-5} or 5 in 100,000

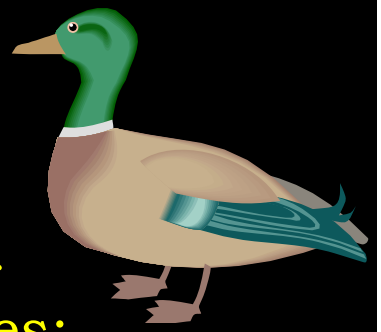
Non-cancer risk: Hazard quotient <1

Conclusion:

Contaminated sediment is **not** a health risk for recreational fishermen, when the conservative assumptions are taken into account.

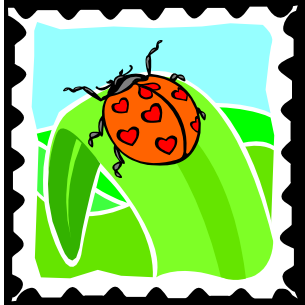


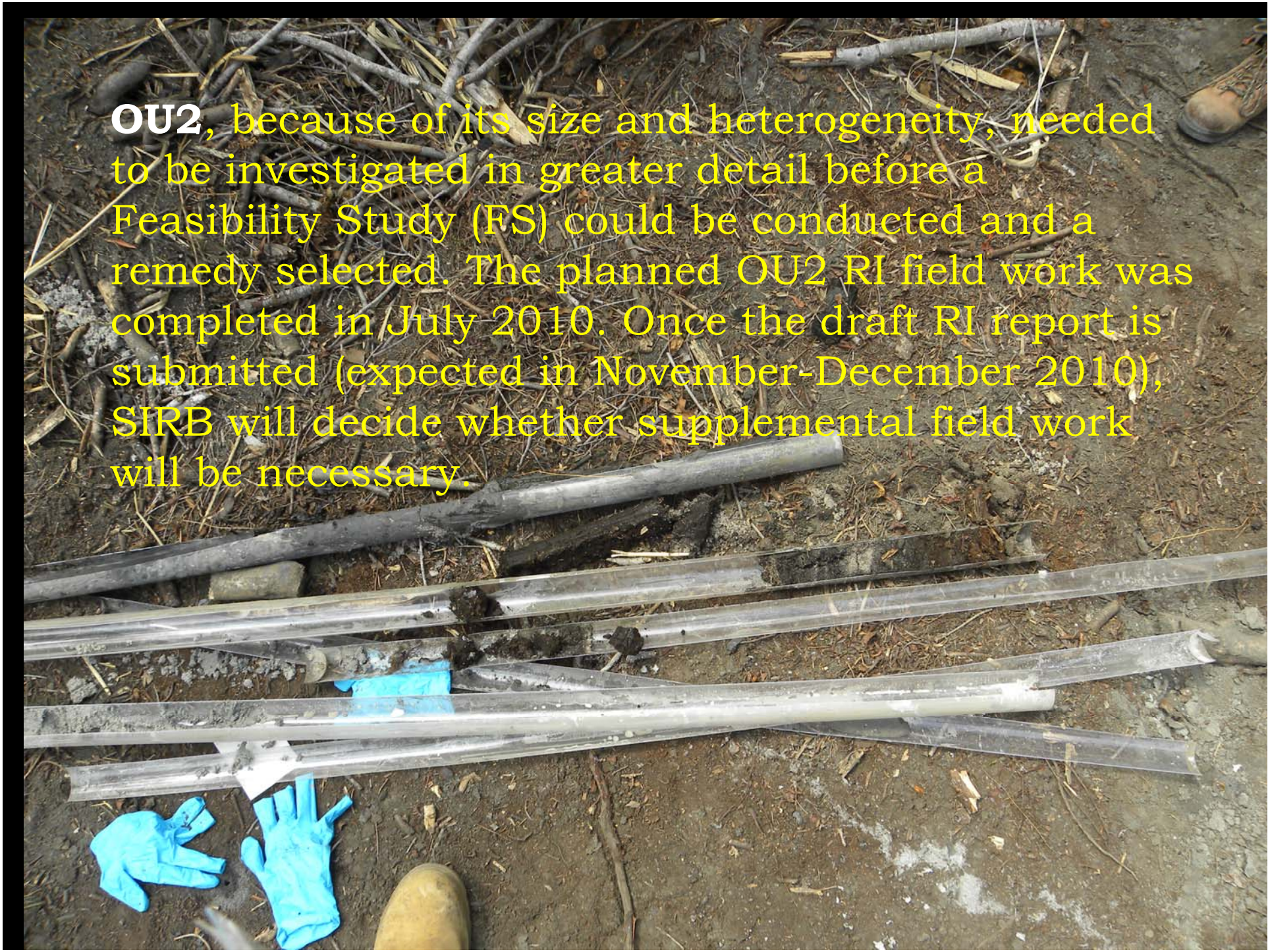
Ecological Risk Assessment



Ecological risk is assessed in a similar fashion, but there are important differences:

- Must account for
  - Many species with widely varying traits and behaviors
    - Body size
    - Biological differences
    - Size of home range compared to exposure area
  - Species' position in "food chain" or "food web": plant, plant eater, meat (insects? fish? mammals?) eater, omnivore, decomposer, etc.
- Can't calculate for every species present
- Little or no data available for many species and substances
  - Use species for which data is available as substitutes for similar species or groups of species ("feeding guilds") that are actually present.




OU2, because of its size and heterogeneity, needed to be investigated in greater detail before a Feasibility Study (FS) could be conducted and a remedy selected. The planned OU2 RI field work was completed in July 2010. Once the draft RI report is submitted (expected in November-December 2010), SIRB will decide whether supplemental field work will be necessary.

OU2 Groundwater

The RI includes a phased groundwater investigation, to include a “desktop” search of available information, development of a Conceptual Site Model for groundwater, and installation of five new monitoring wells (in addition to the eight installed during the FE).

If groundwater risk and contaminant migration pathways cannot be delineated in sufficient detail through this work, SIRB may require additional groundwater investigation.

OU2 RI: Other lines of inquiry

Groundwater migration…

- … to surface water?
- … to deeper/regional aquifers (and potentially to drinking water)?

"Soil" analysis (including uranium and thorium)

Airborne dust monitoring/modeling

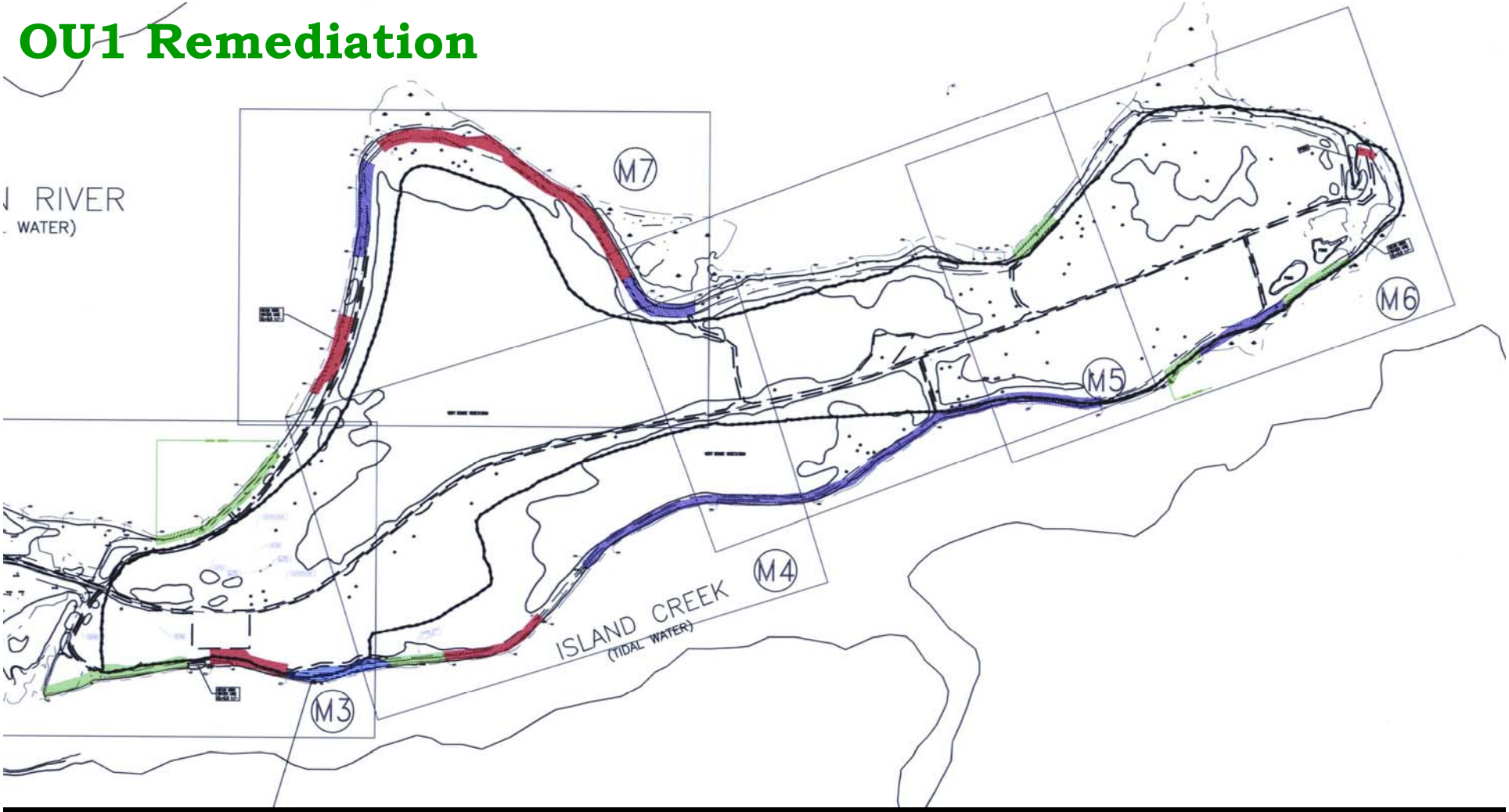
Ecological investigation

- Vegetative/habitat communities
- Ponds at eastern end of island (proposed wetland mitigation)
- Ecological Risk Assessment

Human Health Risk Assessment

- Trespassers (add to OU3 recreational angler risk)
- Site workers
- Possibly regional residential population, if indicated by results of groundwater and air dispersion studies

OU1 Remediation

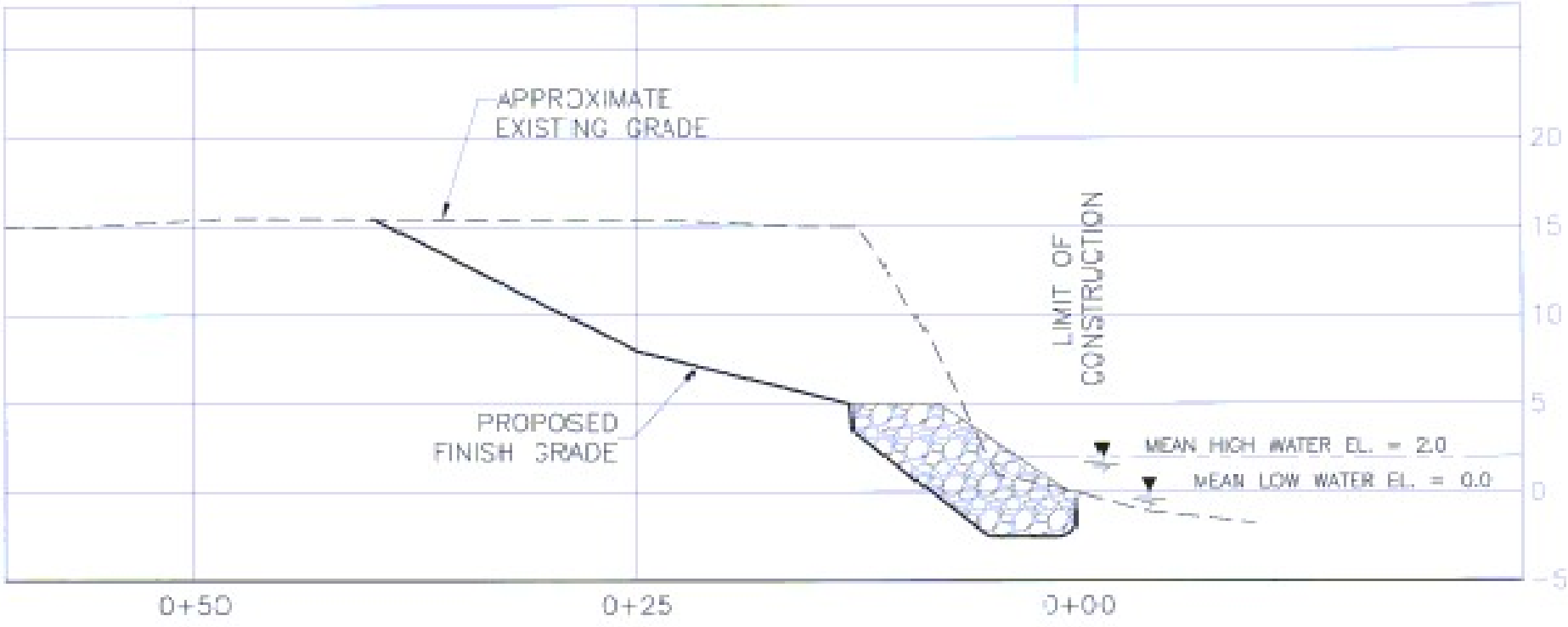


Because the operating plant area was also subject to erosion, NRG decided to address both the plant and the ash disposal area with the same project.

Areas of erosion were mapped as **severe**, **moderate**, or **minimal**.

Drawings by Shaw Environmental, Inc., from the Wetlands and Subaqueous Lands permit application

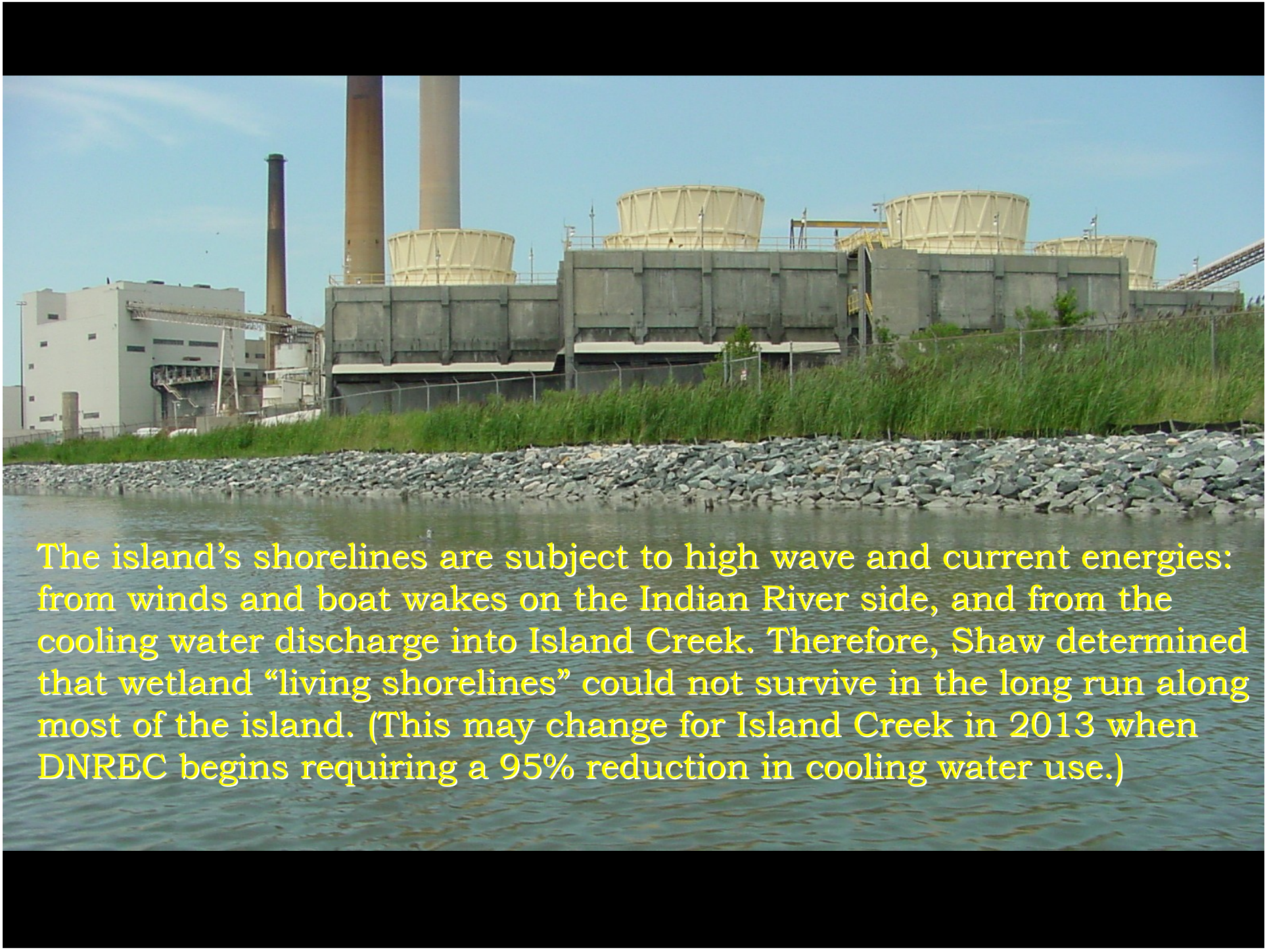
First, the banks were graded. Different grading profiles were specified depending on the degree of erosion.



SEVERE EROSION TYPICAL SECTION A


Large “armor stones” were placed, a few at a time, to create a rip-rap bank.


Exposed berm areas above and behind the rip-rap were
covered with erosion control matting and seeded.


The island's shorelines are subject to high wave and current energies: from winds and boat wakes on the Indian River side, and from the cooling water discharge into Island Creek. Therefore, Shaw determined that wetland "living shorelines" could not survive in the long run along most of the island. (This may change for Island Creek in 2013 when DNREC begins requiring a 95% reduction in cooling water use.)

From ongoing observation of the erosion control work, NRG found that erosion was now occurring in areas that had not been armored during the original project. In the summer of 2010, NRG applied for a permit modification to perform additional erosion control work in the currently unprotected areas.

Since this work would involve destruction of wetland areas along the shoreline, DNREC's Wetlands and Subaqueous Lands Section required mitigation to be performed. NRG proposed constructing new wetlands in the vicinity of pools located in the eastern end of OU2.

SIRB approved the additional erosion control work as Operations and Maintenance (O&M) in September 2010. However, SIRB withheld approval of the proposed **wetland mitigation** site because insufficient data were available to determine whether any contamination in the area might pose a risk to wildlife using the area, or whether the mitigation project would be an "attractive nuisance" bringing wildlife in closer contact with nearby contamination.

An initial determination may be possible once the OU2 RI data are in hand.

However, it may still be necessary to postpone the mitigation project until the OU2 remedial action is performed, or to require the mitigation project to be done at another site.

What's happening now?

- **Remedial Investigation** Report on OU2, including Ecological Risk Assessment, is expected in November-December 2010.
- **Natural Resource Damage Assessment**

This tidal marsh at the Piney Point Tract of the Assawoman Wildlife Area, about a mile downstream of the site, has been selected as the reference area for the ERA and the NRDA.

NRDA

During the summer and fall of 2008, Natural Resource Trustees and other representatives from the U.S Fish and Wildlife Service, NOAA, and DNREC, with NRG and consultants for both sides, toured the site, on land and by boat, to begin identifying critical species and habitats to be evaluated during the NRDA.

Crabs and other invertebrates along Burton Island's shoreline

Pools, wetlands, and inlets within OU2

Areas of bare ash that could present an exposure hazard to wildlife

Primary **natural resource injuries** to be investigated:

- Loss of wetland and subaqueous habitat and reduction in other related natural resource services
- Injury to invertebrates and possibly finfish
- Injury to terrestrial wildlife on the island, and potential loss of upland habitat and ecological services due to OU2 remedial construction
- Potential loss of shoreline habitat and services in perpetuity due to OU1 remedial construction
- Diminished quality of recreational fisheries and other outdoor pursuits on surrounding waters and lands
- Non-use services and hedonic value

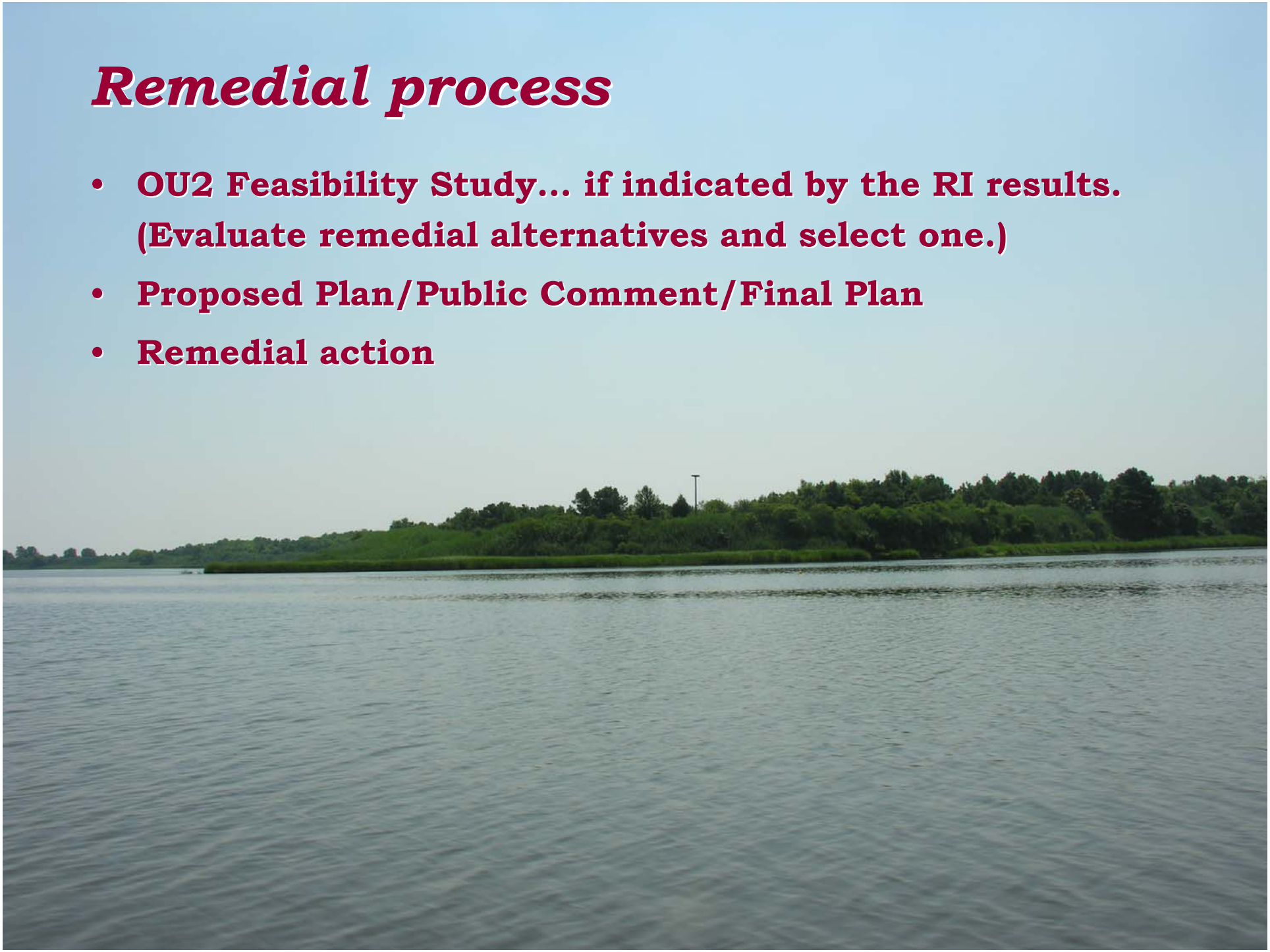
Coal ash: special ecological concerns:

- **Deer** may use coal ash as a **salt lick**. (Sample & Suter, 2002)
- Coal ash exposure causes **developmental impairments** and other damage in certain **frogs, toads, turtles, snakes, fish,** and **crayfish**. (Hopkins, *et al*)
- **Horseshoe crabs** are seasonally present at the reference site and near the study area, suggesting that migratory shorebirds feeding on crab eggs may be at risk.
- Possible **trace metals**, including **uranium** and **thorium** (dependent on coal source.) (Numerous references)


What's next?

Remedial process

- **OU2 Feasibility Study… if indicated by the RI results. (Evaluate remedial alternatives and select one.)**
- **Proposed Plan/Public Comment/Final Plan**
- **Remedial action**



Feasibility Study (FS)

Initial Screening of Remedial Alternatives

- Effectiveness in meeting site cleanup levels
- Appropriate engineering practices based on applicability, feasibility for the site and reliability
- Relative cost

Feasibility Study (FS)

Detailed Analysis of Remedial Alternatives

- Protection of public health and welfare and the environment
- Compliance with applicable laws and regulations
- Community acceptance
- Compliance monitoring requirements
- Permanence
- Technical practicability
- Restoration time frame
- Reduction of toxicity, mobility, and volume of contamination
- Long-term effectiveness
- Short-term effectiveness

Operations and Maintenance

To insure the continued integrity of the remedy, a site-wide *Operations and Maintenance (O&M) Plan* will be required, including at least:

- Monitoring of the erosion control structures.
- Monitoring of the shoreline wetlands.
- Monitoring of sediment contamination offshore.
- Methods of securing the site to prevent public exposure to any contamination.
- Performance Standards for the above.
- Requirements for timely corrective measures as needed.
- Adoption of a Uniform Environmental Covenant restricting future use of the site.

NRDA process

- Damage Assessment Plan.
- Studies to identify and quantify injuries and service losses.
- Possible integration of restoration with remediation – saves resources on both sides, gets to restoration faster.
- Finalize Damage Assessment and present claim.
- On-site and off-site restoration projects to "restore, rehabilitate, replace, or acquire the equivalent" of the resources and services injured or lost.

References

- Hopkins, William, Brandon Staub, Christopher L. Rowe, and Justin Congdon. Accessed Aug. 12, 2008. “Sublethal Impacts of Coal-Derived Trace Elements on Amphibians, Reptiles, and Invertebrates.” *http://www.uga.edu/srelherp/projects/coal.htm*

- Sample, Bradley E., and Glenn W. Suter, October 2002. "Screening Evaluation of the Ecological Risks to Terrestrial Wildlife Associated with a Coal Ash Disposal Site." *Human and Ecological Risk Assessment.* 8:4, 637-656.

- Shaw Environmental, March 2008, on behalf of Indian River Power, LLC. *Final Facility Evaluation Report: Indian River Generating Station Burton Island Old Ash Landfill.*

- Shaw Environmental, April 2010, on behalf of Indian River Power, LLC. *Remedial Investigation Work Plan: Indian River Generating Station, Operable Unit 2, Burton Island Old Ash Landfill*

- Shaw Environmental, April 2010, on behalf of Indian River Power, LLC. *Remedial Investigation Work Plan Addendum.*

SIRB Links

- **Site Investigation and Restoration Branch**
  http://www.awm.delaware.gov/SIRB/Pages/default.aspx

- **SIRB-Related Laws, Regulations, Guidance and Policies**
  http://www.awm.delaware.gov/SIRB/Pages/SIRB_Laws_Regulations_Guidance_Policies.aspx

- **Delaware Regulations Governing Hazardous Substance Cleanup**
  (currently under revision)
  http://www.awm.delaware.gov/SIRB/Documents/HSCA%20Regulations.pdf

- **Burton Island OU1/OU3 Final Plan of Remedial Action**
  http://www.awm.delaware.gov/SIRB/Lists/SIRB%20Plans%20%20Proposed%20and%20Final/Attachments/48/Burton%20Island%20OU-I%20and%20OU-III%20Final%20Plan.pdf

- **SIRB Contaminated Site Files**
  http://apps.dnrec.state.de.us/sitefiles/sirbsitefiles.aspx

U.S. Government Links

- **U.S. Environmental Protection Agency. "Terms of Environment: Glossary, Abbreviations and Acronyms"** *http://www.epa.gov/glossary/*
- **U.S. Environmental Protection Agency. "Arsenic in Drinking Water"** *http://water.epa.gov/lawsregs/rulesregs/sdwa/arsenic/index.cfm*
- **Agency for Toxic Substances and Disease Registry. "ATSDR – Toxic Substances – Arsenic"** *http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=3*
- **Agency for Toxic Substances and Disease Registry. "Toxicological Profile for Arsenic" August 2007** *http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=22&tid=3*

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Robert Gano, DNREC Div. of Fish and Wildlife Regional Manager and Trustee

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