

# The Benefits & Pitfalls of Automation, Alternate Test Procedures, and Extensive Cross Training for Production Gains in a Municipal Environmental Laboratory

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ENVIRONMENTAL SERVICES  
CITY OF PORTLAND

# WHO ARE WE?

WATER POLLUTION  
CONTROL LABORATORY  
6543 N. BURLINGTON

**MID-SIZE MUNICIPAL ENVIRONMENTAL LABORATORY  
ONE OF THREE: GENERAL, DRINKING WATER, & GEOPHYSICAL  
IN PRESENT FACILITY SINCE 1997**



# WHAT DO WE DO?



**DOMESTIC & INDUSTRIAL  
WASTEWATER  
STREAM, STORM, & GROUND WATER  
BIOSOLIDS  
SOILS  
DRINKING WATER**



# HOW DO WE DO IT?



ICP, 2 ICP/MS  
2 GC, 3 GC/MS  
IC, SFA, FIA, DA, TOC  
CN, COD, O&G, ETC., ETC.  
PROMIUM "ELEMENT" LIMS

# THE LAB IN 2001

- VOA GC/MS WORKING (MORE OR LESS)  
SVOA GC/MS INOPERABLE  
FID-GC, USED FOR SOILS HYDROCARBON SCAN  
ECD INACTIVE, SLATED FOR ARACLORS
- ICP (WAY, WAY OVER THE RAINBOW)  
TWO ICP/MS
- OUTDATED IC, OUTDATED FIA
- INADEQUATE LIMS  
ALL DATA HAND-ENTERED  
SAMPLE LABELS & COC DONE OFFLINE
- 15 STAFF
- ~37,000 ANALYSES A YEAR



# DRIVERS FOR GROWTH

- **NEW LONG-TERM PROJECTS**

CSO “BIG PIPE”

WATERSHED MONITORING

- **NEW REGULATIONS**

REASONABLE POTENTIAL ANALYSIS

UNDERGROUND INJECTION CONTROL

TEN-YEAR PERMIT

- **LAB BECOMES A REGIONAL RESOURCE**

10 MUNICIPAL AUTHORITIES

3 OTHER CITY BUREAUS

4 STATE AGENCIES (EX: ODOT)



# WE BEGIN A TEN-YEAR CAPITAL IMPROVEMENT PROCESS

- WE CHANGE ORGANICS VENDOR PLATFORM  
NEW VOA GC/MS SYSTEM  
2 NEW SEMI-VOA GC/MS  
NEW ECD-GC AND FID-GC
- WE REPLACE THE ICP AND BOTH ICP/MS
- WE REPLACE THE IC AND 1 of 2 ANTIQUATED SFAs
- WE ADD A FIA, TOC, & A DISCRETE ANALYZER
- WE SWITCH TO THE FLUORESCENT TAG METHOD IN MICROBIOLOGY



# WE DECIDE TO APPLY FOR NELAP ACCREDITATION

- FIRST, THE OLD LIMS HAD TO GO...
- LIMS REPLACEMENT TAKES TWO YEARS (2009-2010)
- ONE MONTH AFTER LIMS GO-LIVE WE START THE BUMPY ROAD TO ACCREDITATION
- PROCESS TAKES 32 MONTHS: JANUARY 2011 TO SEPTEMBER 2013





# ON TOP OF ALL OF THIS, DESTINY TAKES A HAND...

- CITY ADOPTS “ZERO-BASE” BUDGETING (2008)
- IMPOSSIBLE TO ADD ADDITIONAL STAFF
- EPA METHODS APPROVED AT 40 CFR 136 ARE...  
ANTIQUATED (MOSTLY ORGANICS)  
SLOW (METALS & ORGANICS PREP)  
MACRO-SCALE (ORGANICS)



# WE STRUGGLE TO KEEP THINGS GOING

- EXTENSIVE CROSS TRAINING IN THE ANALYST POOL
- EVERY BENCH/CONVENTIONAL ANALYSIS HAS ONE BACKUP, MOST HAVE TWO
- THE LIMS ALLOWS ELECTRONIC DATA TRANSFER FROM INSTRUMENTS AND BAR CODING
- WE ADD **LARGE VOLUME INJECTORS** TO ORGANICS INSTRUMENTS TO KEEP UP WITH DEQ DETECTION LIMIT REQUIREMENTS AND ALLOW FOR **MICRO-EXTRACTION**



# WE STREAMLINE METHODS

- OVER TIME WE GET EPA/DEQ APPROVAL FOR ALTERNATE TEST PROCEDURES VIA 40 CFR 136.5 & 136.6
- THREE FULL-BORE ATPs, INCLUDING
  - Hg BY MICROWAVE FOLLOWED BY ICP/MS
  - ADDITIONAL METALS TO CEM MICROWAVE METHOD
- THREE STREAMLINED METHOD MODIFICATIONS, INCLUDING
  - TOTAL P BY MICROWAVE FOLLOWED BY ICP/MS
  - MICRO-EXTRACTION/LVI FOR EPA 625
- SIX OTHER METHOD MODIFICATIONS, INCLUDING
  - WATER/METHANOL MICRO-EXTRACTION WITH LVI FOR PCBs IN SOIL
  - GC/MS-SIM AS THE DETERMINATIVE STEP IN EPA 515.4 FOR UIC MONITORING





# AREN'T WE GREAT!

## WPCL PERFORMANCE OVER 15 FISCAL YEARS

FY	# STAFF	# IN-HOUSE ANALYSES	# OUTSIDE ANALYSES	IN-HOUSE REVENUE	OUTSIDE COST*
2002	15	36,918	3,410	\$1,268,568	\$435,006
2016	15	57,211	1,106	\$2,049,192	\$92,178
Δ	0 !!!	+55.0%	-67.6%	+61.5%	-78.8%

\* Cost for all lab work sent to contract laboratories.

(\$113.6K for special fish study not included in FY 16 outside costs)



# CRACKS APPEAR IN THE FOUNDATION

- THE “PERFECT STORM” HITS AT THE BEGINNING OF THE 2015-16 WINTER SAMPLING SEASON
- BES’ OWN FIELD OPERATIONS MOBILIZES EVERYBODY
- FIVE OUTSIDE MUNICIPALITIES MOBILIZE EVERYBODY
- SOIL SAMPLING BEGINS AT THREE CIPs



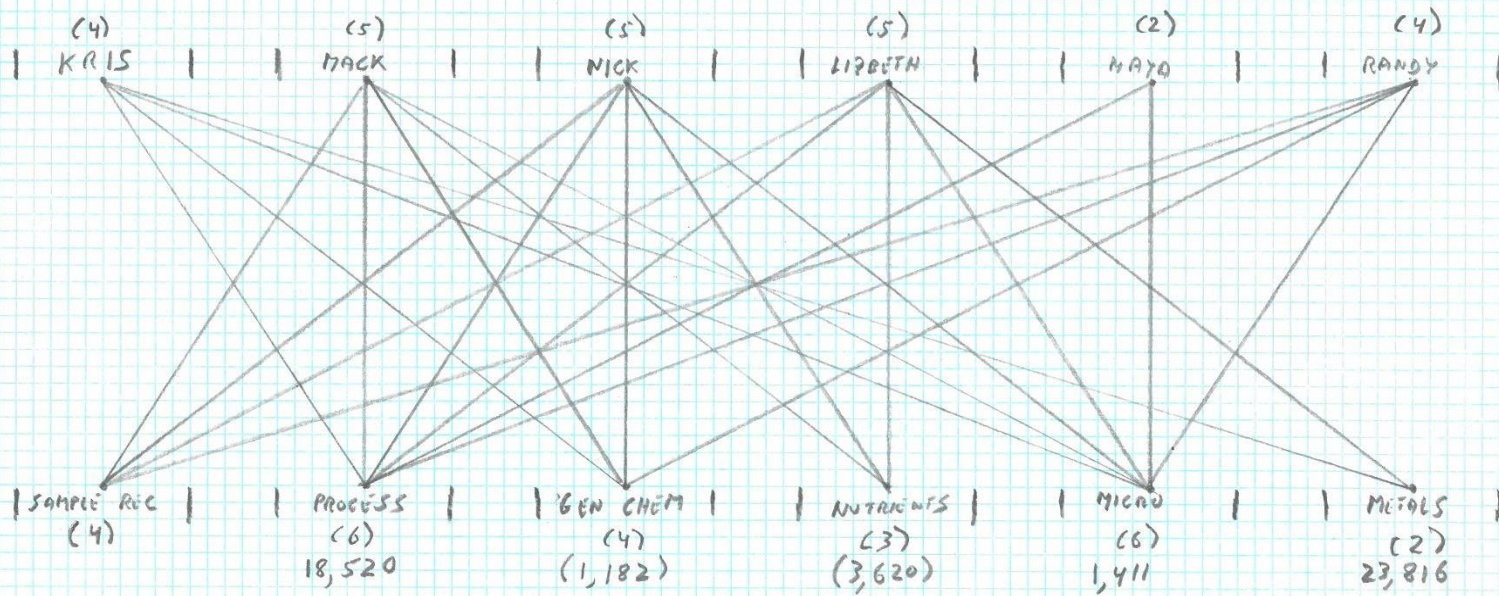
# WE ALMOST GO UNDER

- EXTENSIVE CROSS TRAINING ALLOWS US TO PUT FOUR ANALYSTS IN SAMPLE RECEIVING
- TWO THINGS HAPPEN SIMULTANEOUSLY:
  - 1) PROCESS CONTROL GETS NEGLECTED
  - 2) LOG-IN BACKS UP BECAUSE THERE'S ONLY ONE WORK FLOW POSSIBLE IN SAMPLE RECEIVING
- WE PULL TWO ANALYSTS BACK INTO PROCESS BUT ARE NOW BURNING OUR CANDLE AT BOTH ENDS
- RESULT: WE MISS HOLD TIMES ON IMPORTANT SAMPLES
- ROOT CAUSE?



**IT'S WORKFLOW, NOT THE NUMBER  
OF BODIES**





# WHY IS OUR FED-EX BILL SO HIGH?

- PROBLEM IS IN PROCESS CONTROL/GENERAL CHEM
- WE'RE CONSTANTLY RUNNING OUT OF REAGENTS
- WE'RE CONSTANTLY RUNNING OUT OF STANDARDS
- SIX ANALYSTS COVER OVER TWENTY BENCH ANALYSES
- ALL ANALYSTS HIGHLY CROSS TRAINED
- ROOT CAUSE?

**WHEN EVERYBODY'S IN CHARGE,  
NOBODY'S IN CHARGE!**



# WHY IS THE ION CHROMATOGRAPH STILL DOWN?

- THREE ANALYSTS ROTATING AMONG FOUR INSTRUMENTS
- ALL THREE ALSO ROTATE THROUGH PROCESS/GENERAL
- ALL THREE ALSO WORK IN SAMPLE RECEIVING
- ONE ANALYST DOUBLES-DOWN IN METALS PREP
- ROOT CAUSE?

**NOBODY SPENDS ENOUGH TIME ON  
ANY ONE INSTRUMENT TO GAIN  
ANALYTICAL “WISDOM”**





# WHY CAN'T WE DO THIS?

- IN METALS: USING SW-846 METHODS FOR CWA ANALYSES
- IN METALS: ADDING ANALYTES NOT APPROVED IN CWA METHODS
- IN ORGANICS: NOT DOCUMENTING “IMPROVEMENTS” TO PROCEDURAL DETAILS
- ROOT CAUSE?

**NOT PAYING STRICT ATTENTION TO  
THE DETAILS OF 40 CFR 136 METHODS**



# ARE WE THERE, YET?

## CORRECTIVE ACTIONS (#1)

- IN SAMPLE RECEIVING, CREATED A SECOND WORK FLOW WITH NEW LIMS TERMINAL & MORE SPACE. ALSO STARTED A COLLABORATIVE PROJECT ALERT SYSTEM TO AVOID GETTING “MOBBED.” ALSO INITIATED A WEEKLY CHECK-IN WITH ANALYSTS
- IN PROCESS CONTROL, ASSIGNED SEVERAL ANALYSTS TO MONITOR SUPPLIES DAILY
- IN THE NUTRIENTS SECTION, INITIATED A WEEKLY CHECK-IN, BUT HAVE YET TO WORK OUT THE MECHANISMS FOR ANALYSTS TO BETTER GAIN “ANALYTICAL WISDOM” (UNION CBA MAY COME INTO PLAY, HERE)



Needs to be

Ordered

Needed By

Ordered

Rcvd

Phosphate Buffer

HOT PLATES

100ml volumetric pipet

250 mL Beakers

Residual  $Cl_2$  std

LBOD Sensor cap

MAY 15<sup>th</sup>

ASAP - only 5 left

04-24

05-05

05-05

05-05

5/8 @

5/8 @

number:

Refrigerator

°C Bottom	Date
2.6	1
5.5	2
1.8	3
6.0	4
0.5	5
1.5	6
1.0	7
2.5	8
4.5	9
6.0	10
4.0	11
2.5	12
3.0	13
1.9	14
2.2	15
	16
	17
	18
	19
	20
	21
	22
	23
	24
	25



# ARE WE THERE, YET?

## CORRECTIVE ACTIONS #2

- DEVELOPED AN ATP REVIEW PROTOCOL.
- IN METALS, REVIEWED CWA ANALYTICAL REQUIREMENTS AND WORKED UP FIVE ATPs
- IN ORGANICS, FIRST STEPS CAME OUT OF A NELAP PRE-APPLICATION SYSTEMS AUDIT BY MARLENE MOORE OF ADVANCED SYSTEMS
  - 1) SOPs MUST REFLECT CURRENT PRACTICES
  - 2) DON'T APPLY SW-846 SOLUTIONS TO CWA WORK
  - 3) DON'T LET DRIVE FOR PRODUCTIVITY BYPASS DOCUMENTATION
- ALSO REVIEWED ORGANICS CWA ANALYTICAL REQUIREMENTS AND WORKED UP ONE ATP AND FIVE STREAMLINED METHOD MODIFICATIONS



# ARE WE THERE, YET?

## HOPE FOR THE FUTURE

- BECAUSE OF UNION CBA, IN NUTRIENTS MUST DEVELOP INSTRUMENT OWNERSHIP WITHOUT INVOKING “LEAD WORKER” STATUS (STILL WORKING ON THIS)
- 2<sup>ND</sup> VOA GC/MS TO IMPROVE WORKFLOW (7/17)
- POSSIBLE ACCELERATED CAPITAL PLAN TO PURCHASE A TRIPLE-QUAD GC/MS TO SPEED UP SAMPLE PREP WHILE SIMUTANEOUSLY LOWERING QLs
- RE-EXAMINATION OF ENTIRE CROSS TRAINING EFFORT
- WILL THE ECONOMY ALLOW US TO ADD STAFF??



# BIGGER QUESTIONS

- ARE WE DRIVING JUNIOR STAFF TOO HARD? (THE ALLEGORY OF THE SCHOOL BUS)
- COULD FURTHER GROWTH WITHOUT INCREASING STAFF COMPROMISE QA/QC, WORKER HEALTH & SAFETY?
- ARE WE GOING TO HAVE TO LEARN TO “JUST SAY NO?” (EXAMPLE: HELPING OUT THE WATER BUREAU WITH THE LEAD-IN-SCHOOL-DRINKING-WATER CRISIS)



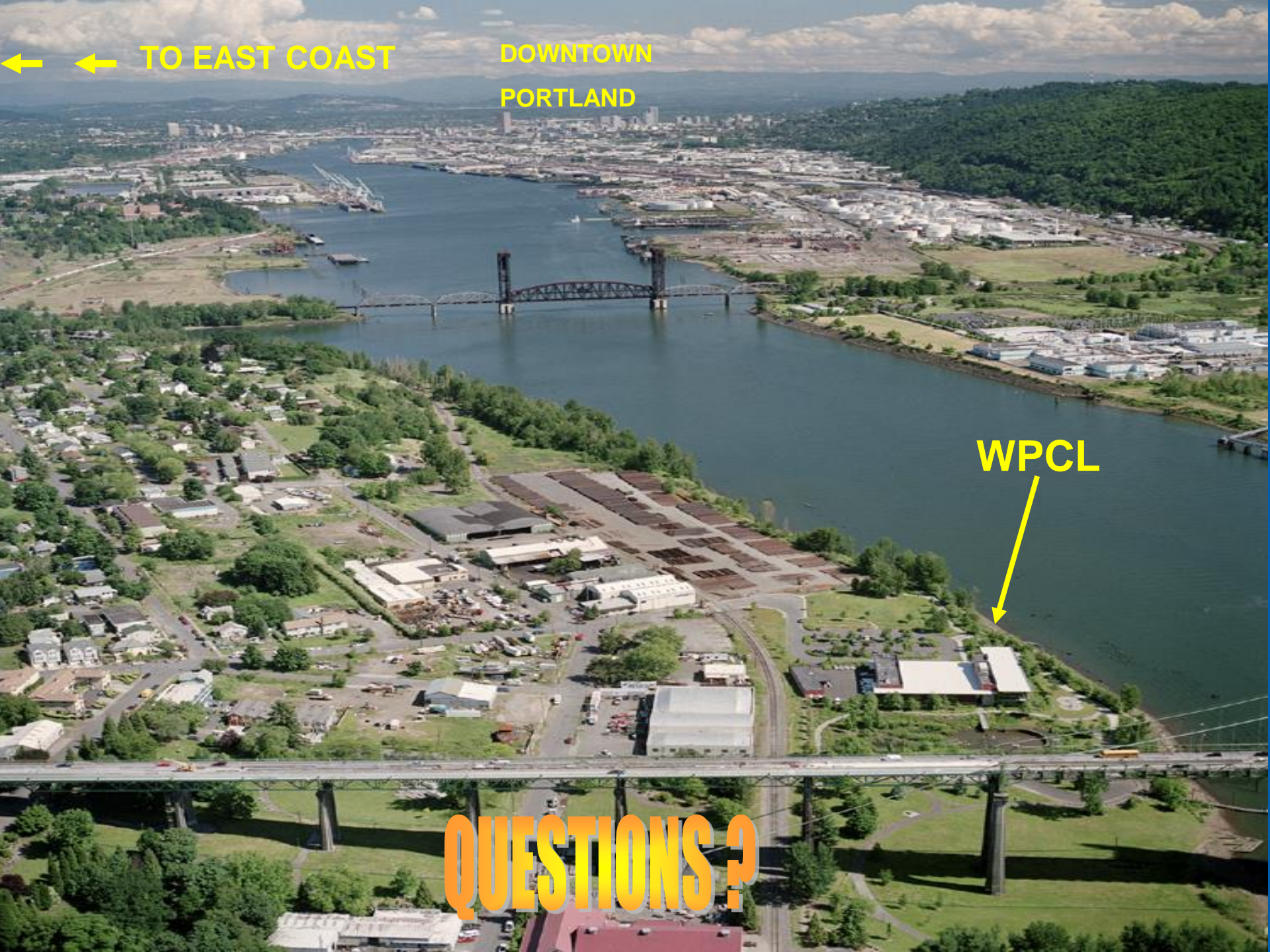
**MY TWO CO-AUTHORS WHO ALSO EXCEL  
AT MAKING THE LAB MANAGER LOOK GOOD!**



**JENNIFER SHACKELFORD (QA)**

**KRISTEN THOMAS (PRODUCTION)**





← ← TO EAST COAST

DOWNTOWN  
PORTLAND

WPCL

QUESTIONS?