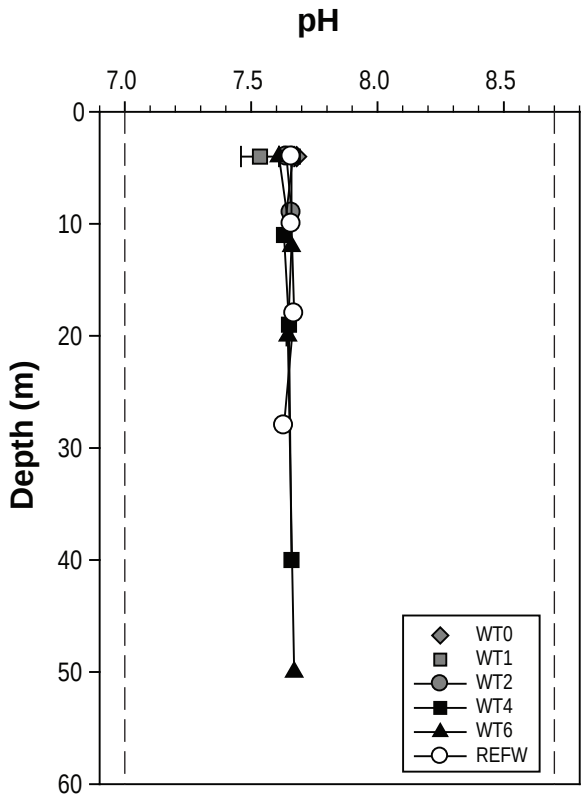
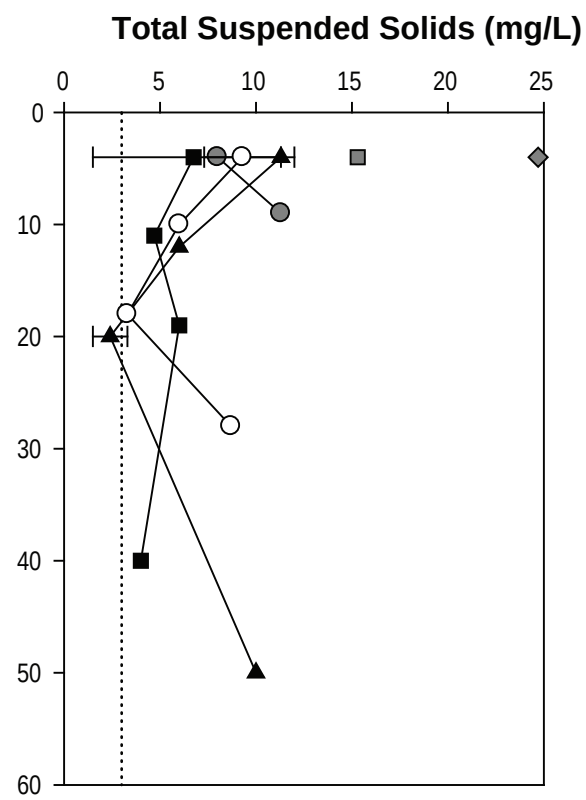
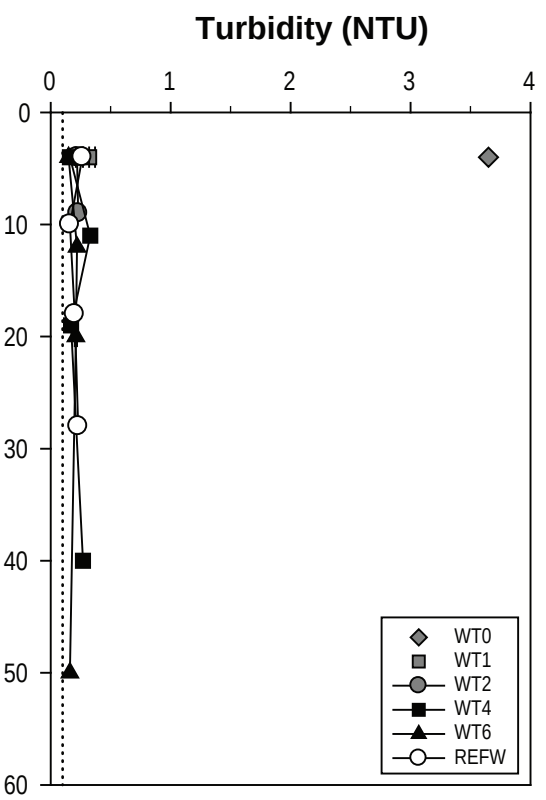


Notes: Error bars are standard error of the mean.
Analytical detection limit = 0.1 pH units.
Dashed lines represent CCME water quality guideline (pH 7.0–8.7).



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (3 mg/L).
CCME guideline: maximum increase of 25 mg/L from background levels for short-term exposure, and maximum average increase of 5 mg/L from background levels for longer-term exposure.



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.1 mg/L).
CCME guideline: maximum increase of 8 NTU from background levels for short-term exposure, and maximum average increase of 2 NTU from background levels for longer -term exposure.

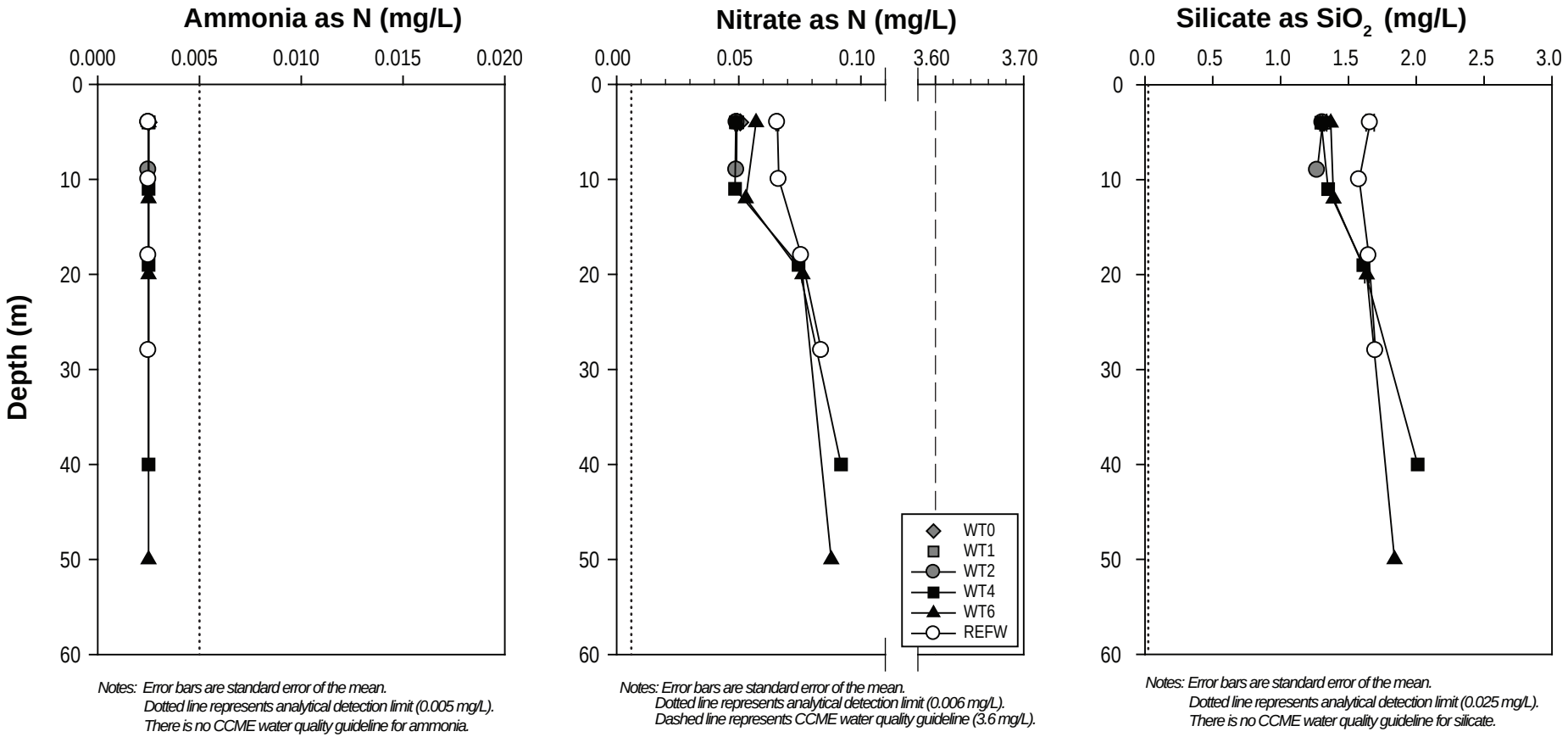
Figure 3.5-1

NEWMONT NORTH AMERICA

pH, Total Suspended Solids, and Turbidity in Roberts and Reference Bays, Hope Bay Belt Project, April 2009

Figure 3.5-1

Rescan™ Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.005 mg/L).
There is no CCME water quality guideline for ammonia.

Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.006 mg/L).
Dashed line represents CCME water quality guideline (3.6 mg/L).

Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.025 mg/L).
There is no CCME water quality guideline for silicate.

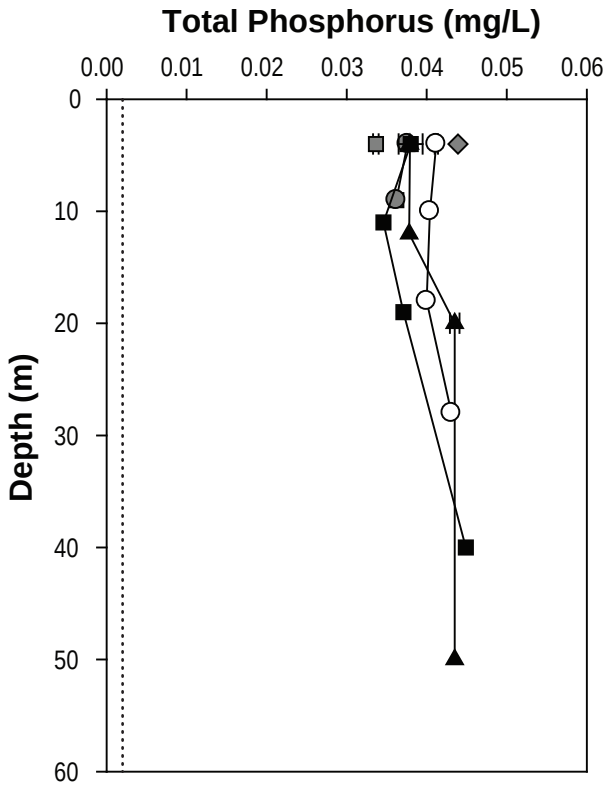
Figure 3.5-2

NEWMONT NORTH AMERICA

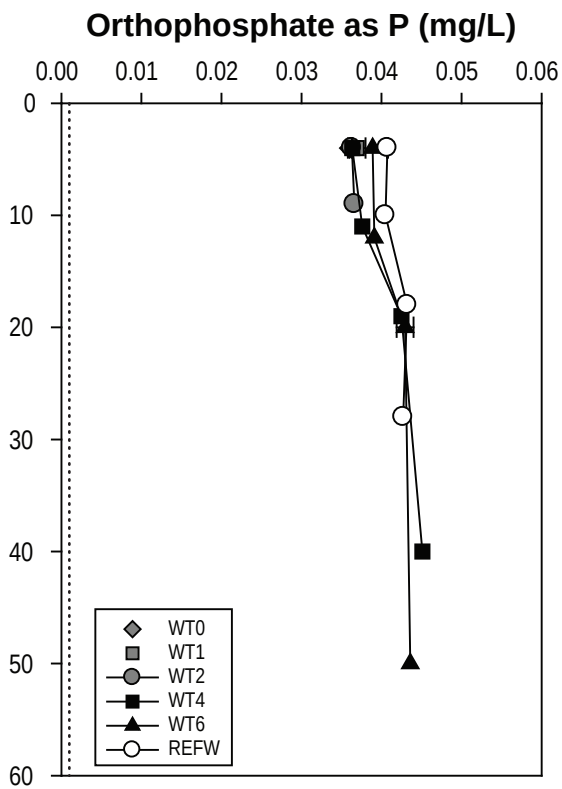
Ammonia, Nitrate, and Silicate Concentrations in Roberts and Reference Bays, Hope Bay Belt Project, April 2009

Figure 3.5-2

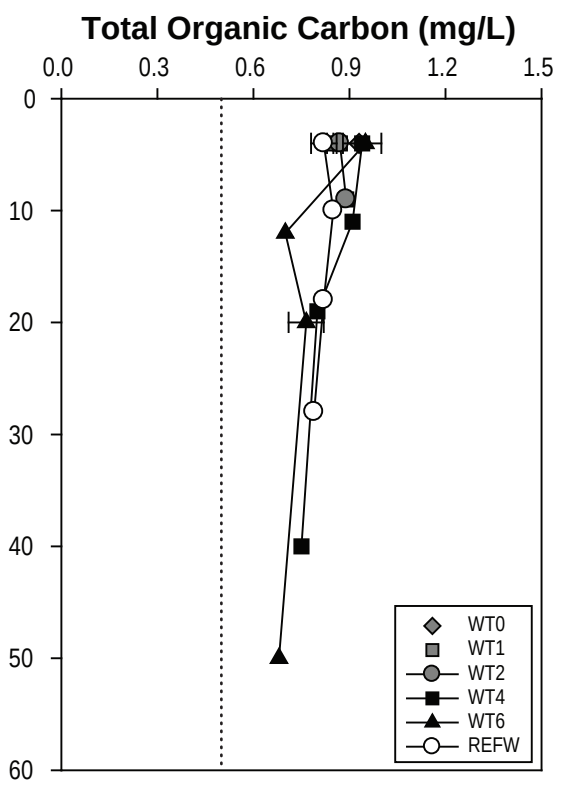
Rescan™ Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.002 mg/L).
There is no CCME water quality guideline for total phosphorus.



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.001 mg/L).
There is no CCME water quality guideline for orthophosphate.



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.5 mg/L).
There is no CCME water quality guideline for total organic carbon.

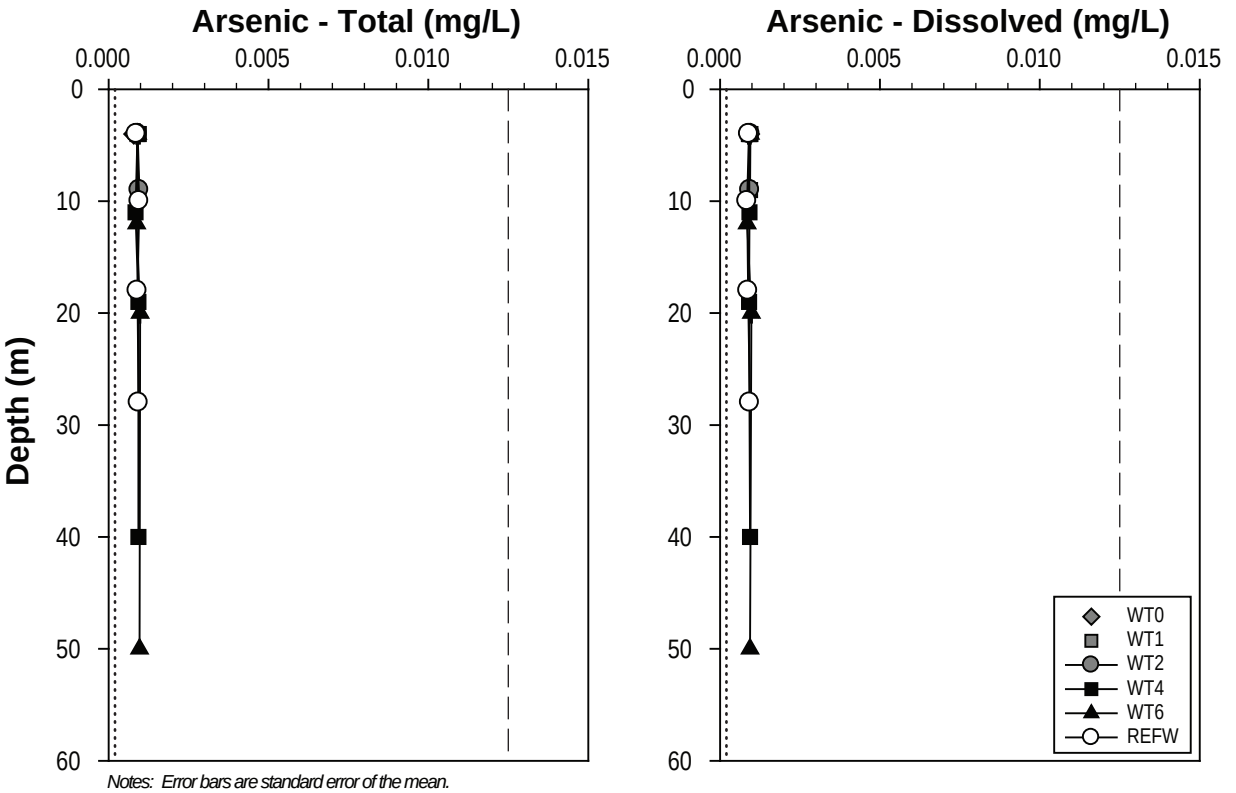
Figure 3.5-3

NEWMONT NORTH AMERICA

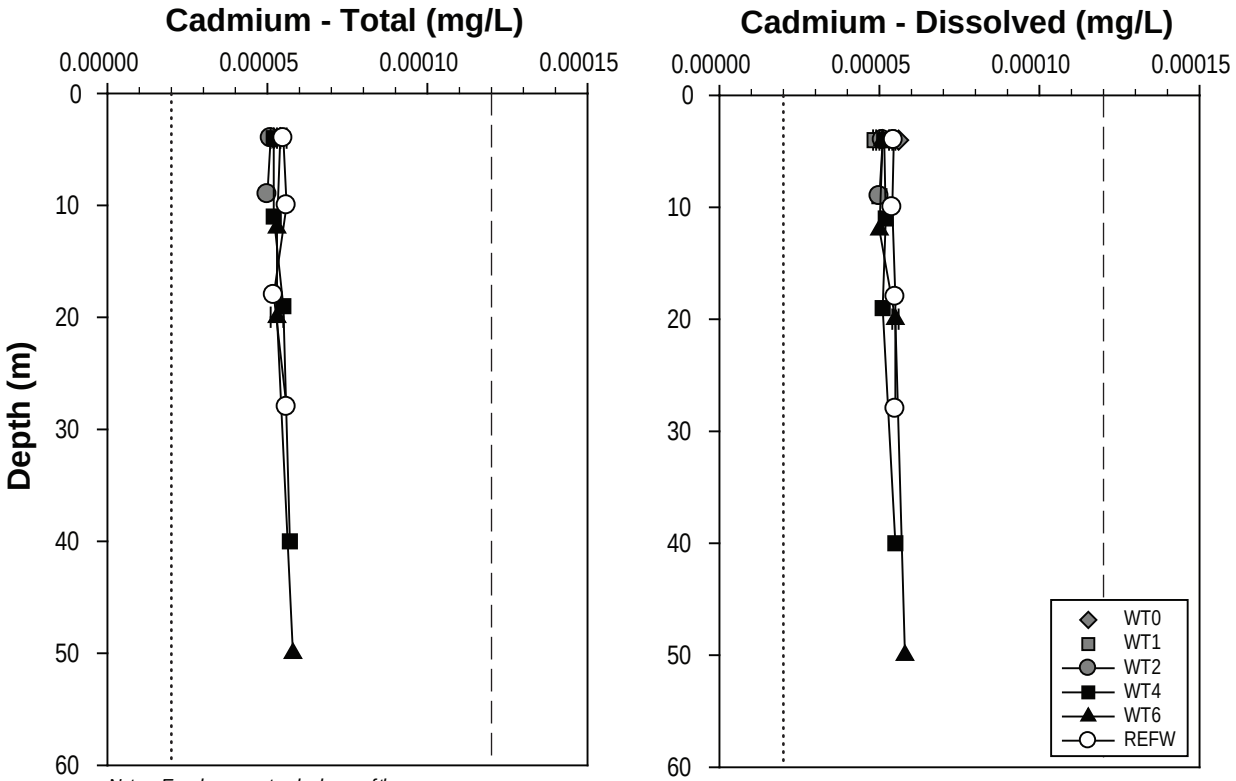
Total Phosphorus, Orthophosphate, and Total Organic Carbon Concentrations in Roberts and Reference Bays, Hope Bay Belt Project, April 2009

Figure 3.5-3

Rescan™ Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.0002 mg/L).
Dashed line represents CCME water quality guideline (0.0125 mg/L).



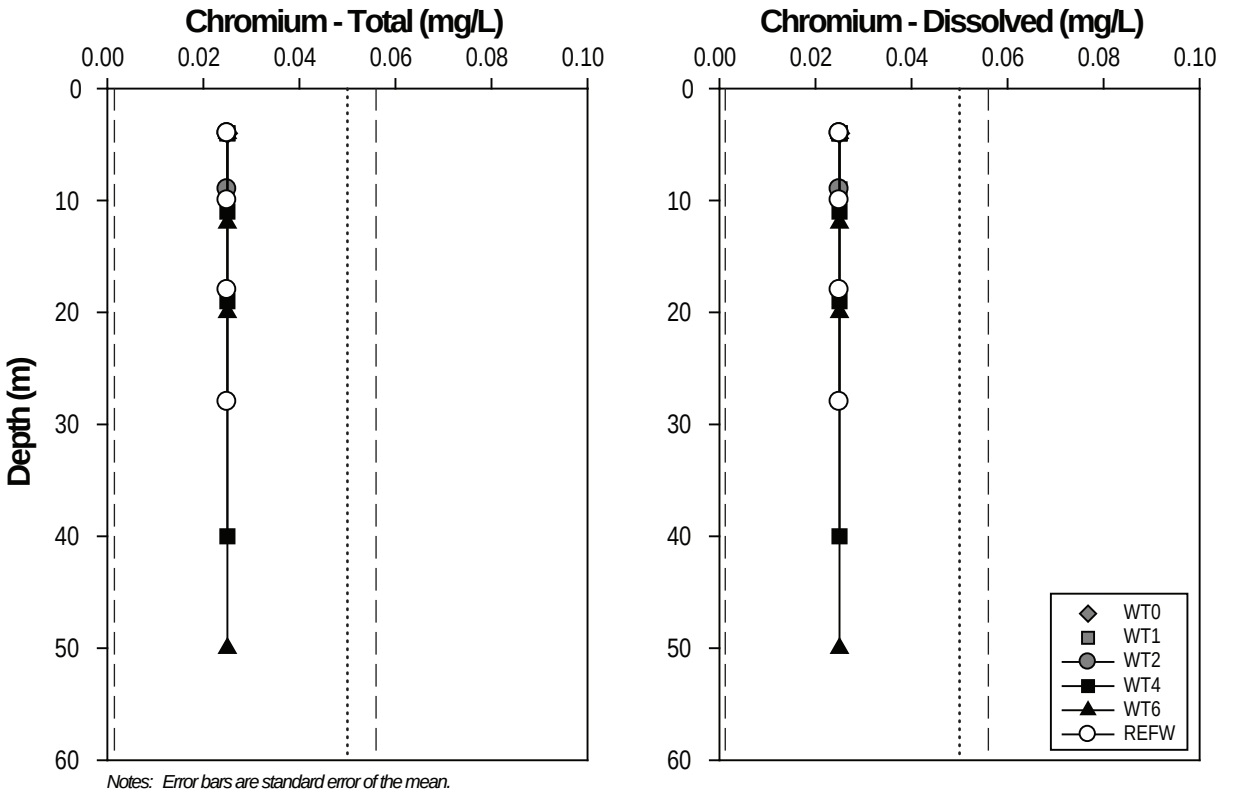
Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.00002 mg/L).
Dashed line represents CCME water quality guideline (0.00012 mg/L).

NEWMONT NORTH AMERICA

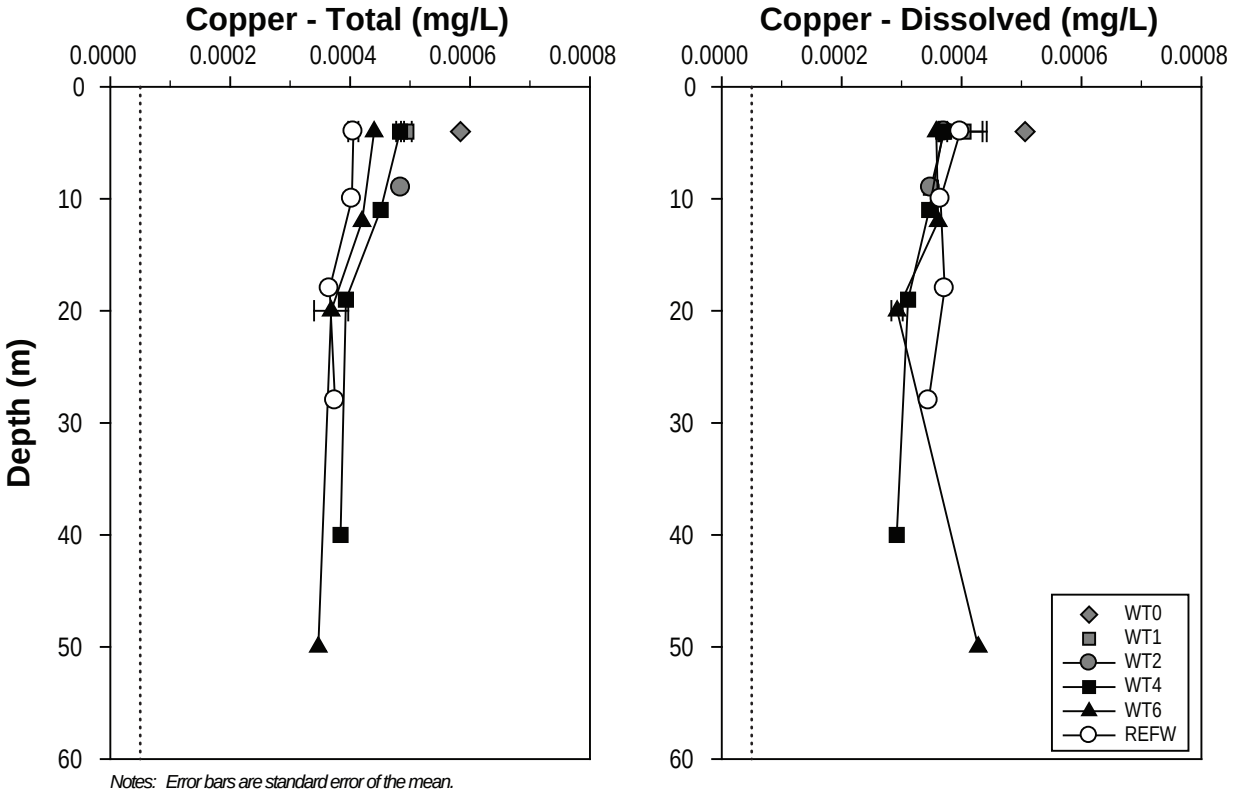
Arsenic and Cadmium Concentrations in Roberts and Reference Bays, Hope Bay Belt Project, April 2009

Figure 3.5-4

Rescan™ Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.05 mg/L).
Dashed lines represents CCME water quality guideline of 0.056 mg/L for Cr(III) and 0.0015 mg/L for Cr (VI).



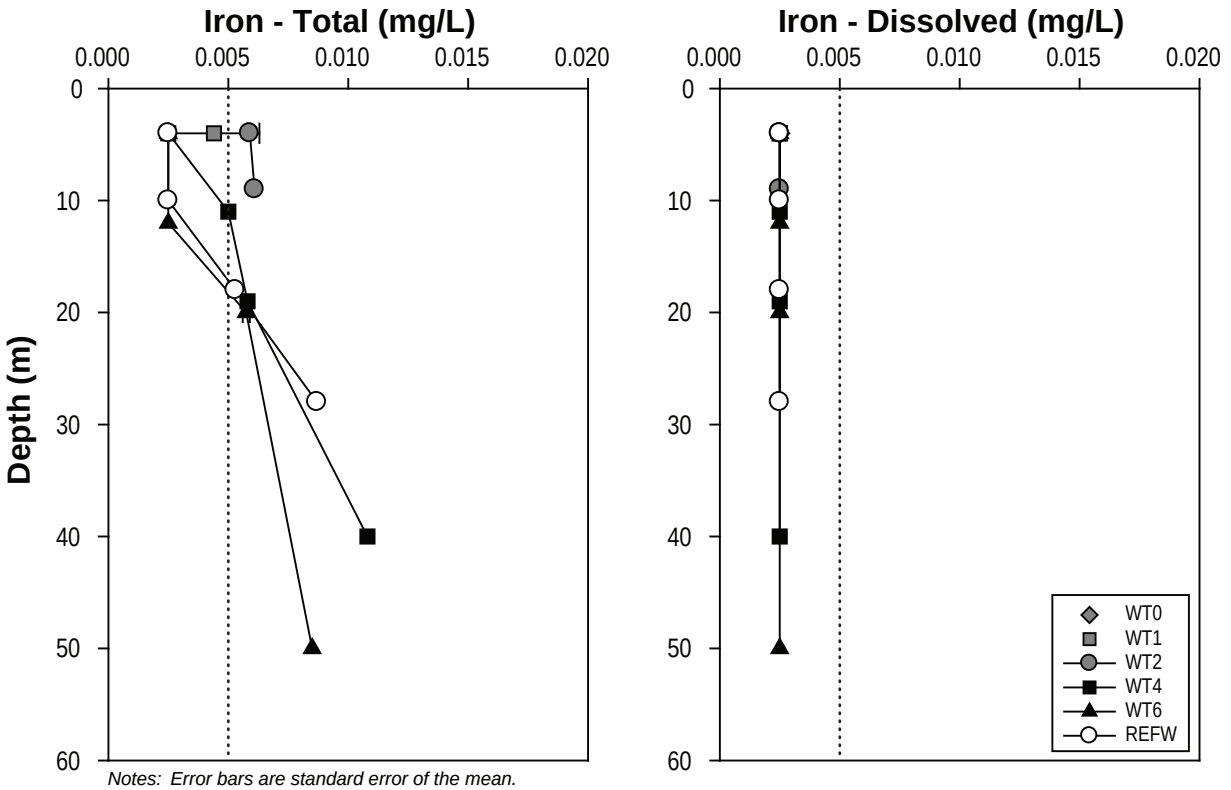
Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.00005 mg/L).
There is no CCME water quality guideline for copper.

NEWMONT NORTH AMERICA

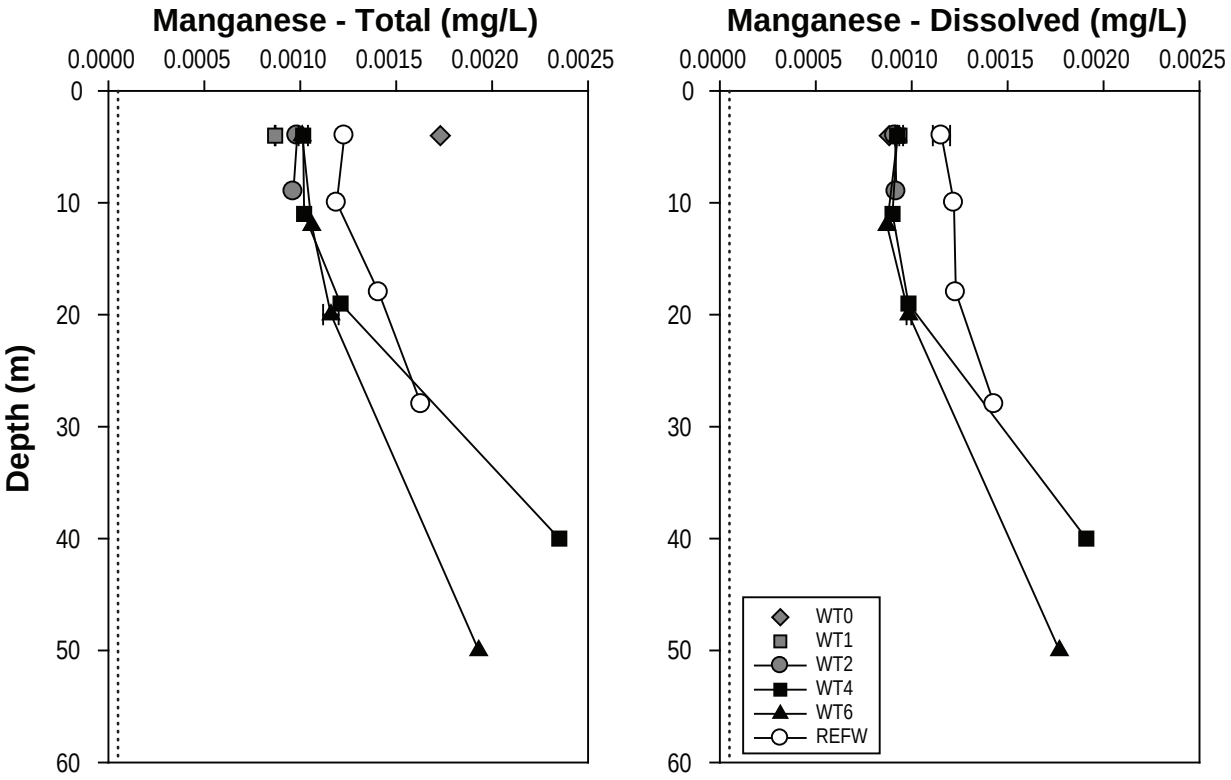
Chromium and Copper Concentrations in Roberts and Reference Bays, Hope Bay Belt Project, April 2009

Figure 3.5-5

Rescan Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.005 mg/L).
There is no CCME water quality guideline for iron.



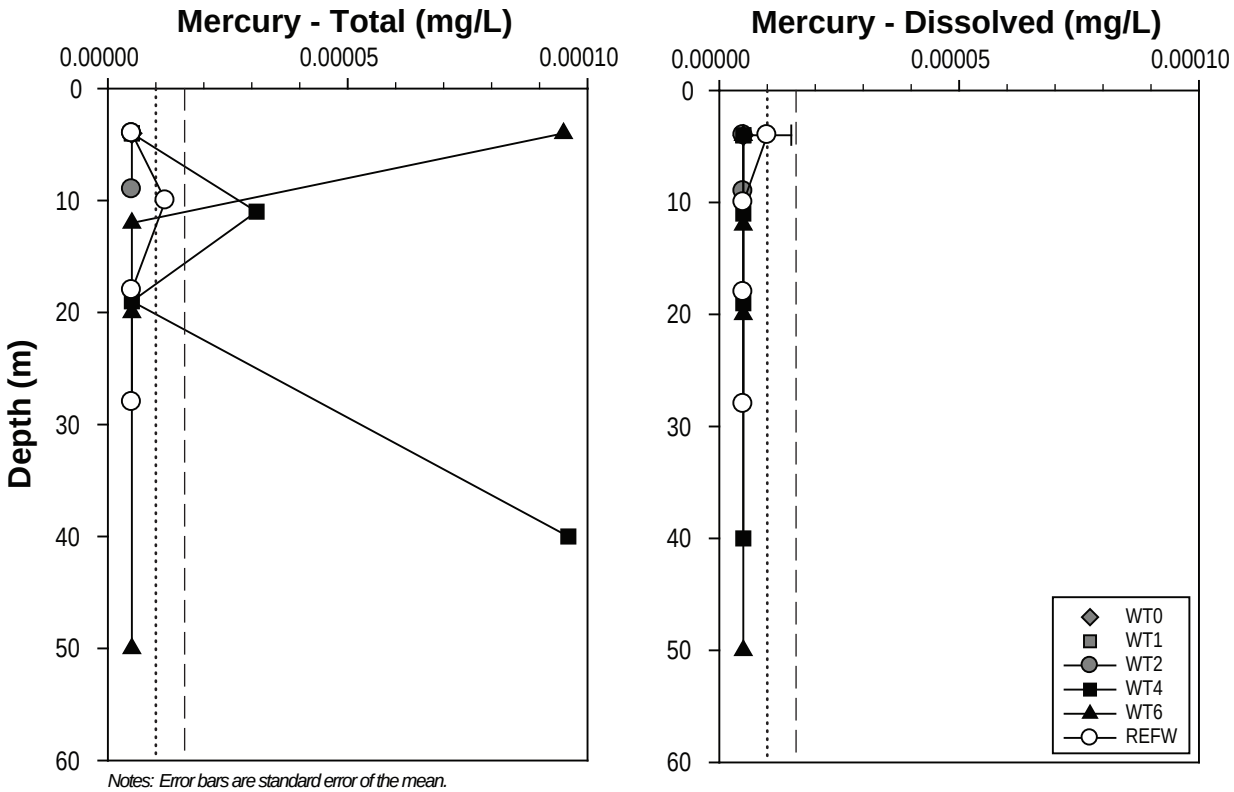
Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.00005 mg/L).
There is no CCME water quality guideline for manganese.

NEWMONT NORTH AMERICA

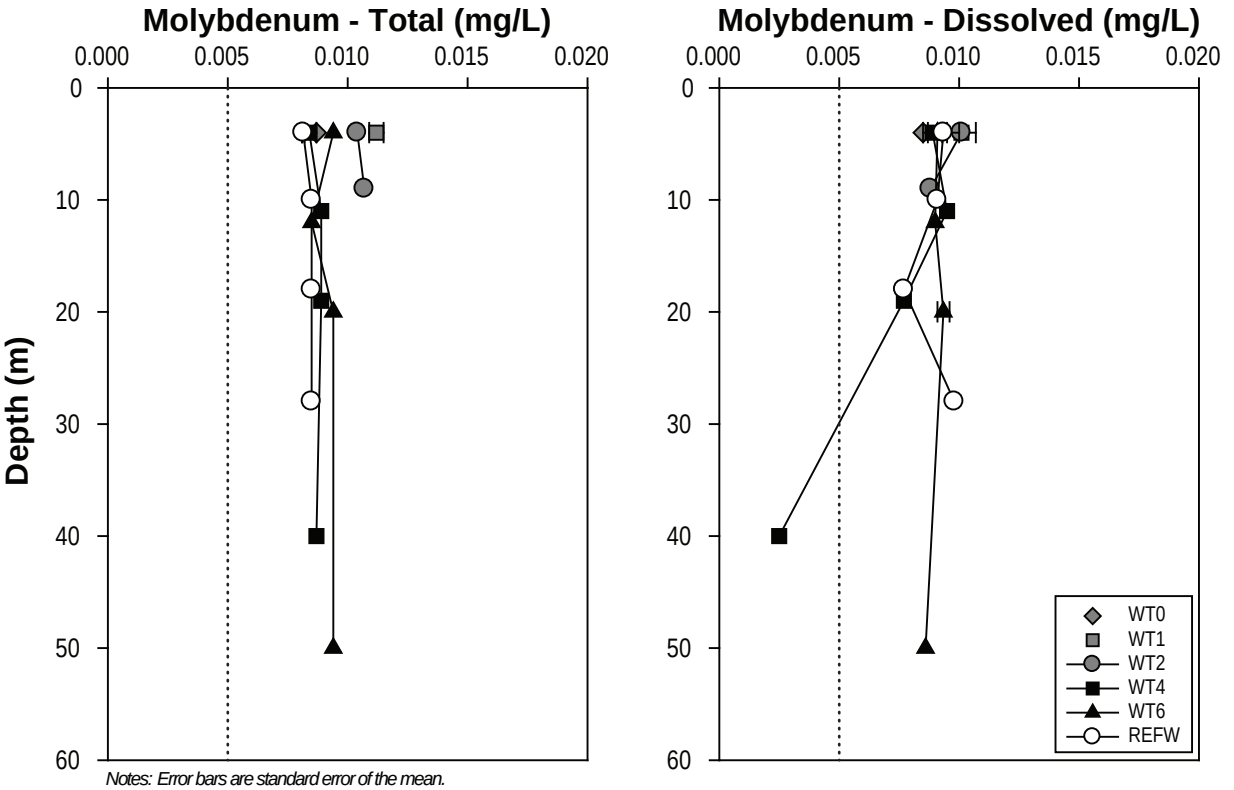
Iron and Manganese Concentrations in Roberts and Reference Bays, Hope Bay Belt Project, April 2009

Figure 3.5-6

Rescan Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.00001 mg/L).
Dashed line represents CCME water quality guideline (0.000016 mg/L).



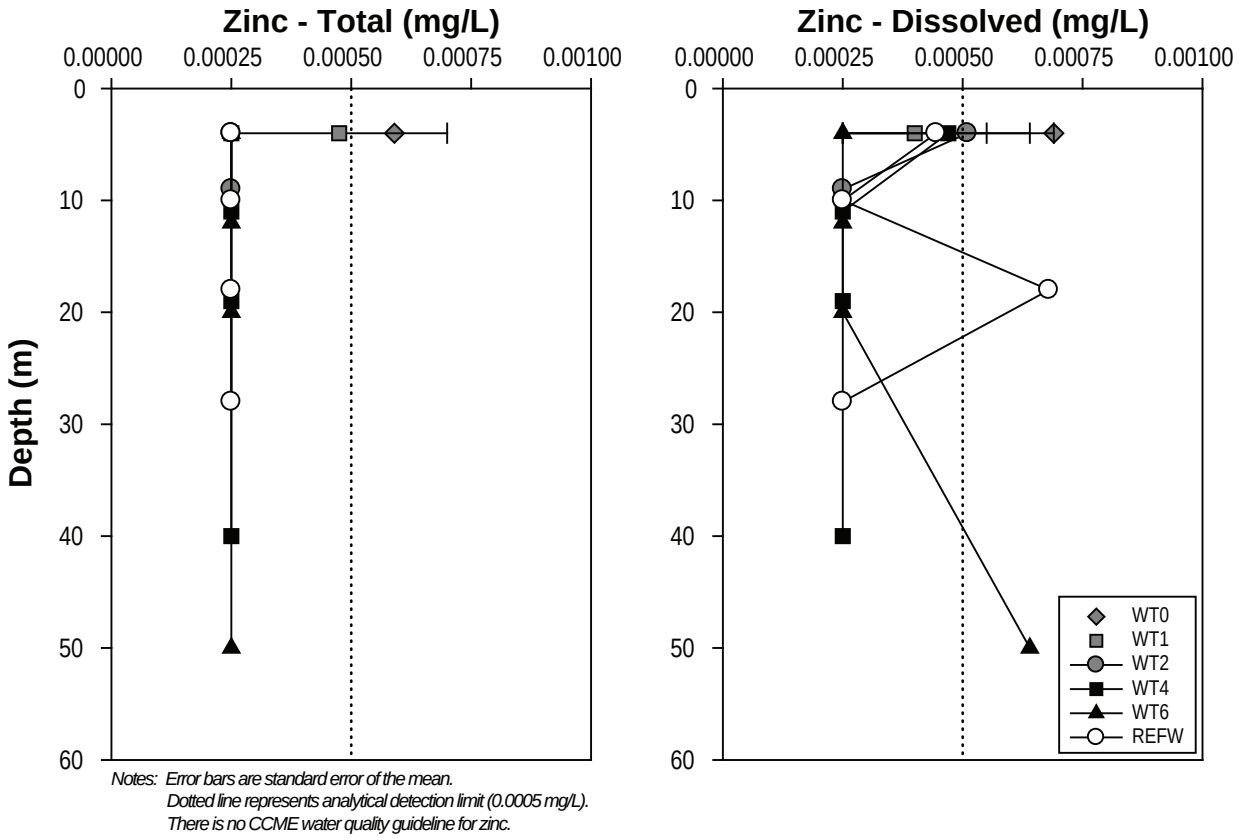
Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.005 mg/L).
There is no CCME water quality guideline for molybdenum.

NEWMONT NORTH AMERICA

Mercury and Molybdenum Concentrations in Roberts and Reference Bays, Hope Bay Belt Project, April 2009

Figure 3.5-7

Rescan Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.0005 mg/L).
There is no CCME water quality guideline for zinc.

Zinc Concentrations in Roberts and Reference Bays, Hope Bay Belt Project, April 2009

Figure 3.5-8

NEWMONT NORTH AMERICA

Rescan™ Engineers & Scientists

Nutrient levels were generally similar among sites in Roberts and Reference bays, and slight vertical concentration gradients were apparent for some nutrients (Figures 3.5-2 and 3.5-3). Surface total phosphorus concentrations ranged from 0.034 mg/L at WT1 to 0.044 mg/L at WT0, and bottom water total phosphorus reached a maximum of 0.045 mg/L at WT4 (at 40-m depth). Bioavailable orthophosphate made up the majority of the total phosphorus pool (Figure 3.5-3). Nitrate concentrations in the surface layer ranged from 0.049 mg/L at WT4 to 0.066 at REFW, and reached a maximum of 0.092 mg/L below the pycnocline at site WT4 (Figure 3.5-2). Nitrate and orthophosphate concentrations were slightly lower at the surface than in deep waters, particularly at the Roberts Bay sites. Total ammonia levels were always below detection limits (<0.005 mg/L; Figure 3.5-2) and nitrite concentrations ranged from below detection limits (<0.002 mg/L) to slightly above detection (0.0028 mg/L: Appendix 3.5-1). Concentrations of silicate ranged from 1.3 mg/L at WT2 to 1.7 mg/L at REFW in surface waters, and reached a maximum of 2.0 mg/L at WT4 at 40-m depth (Figure 3.5-2). Silicate levels at Roberts Bay sites were slightly reduced at the surface relative to deep waters, but this trend was not apparent at the Reference Bay sampling station. Total organic carbon (TOC) concentrations ranged from 0.68 mg/L at WT6 at 50-m depth to 0.95 mg/L at the same site at 4-m depth (Figure 3.5-3). Surface concentrations of TOC tended to be slightly higher than bottom water concentrations. Vertical gradients characterized by higher TOC and lower nutrients at the surface than at depth suggest that phytoplankton or epontic (algae associated with lower ice layer) growth was occurring at Roberts and Reference Bay sites during the winter sampling period.

The weaker vertical gradient in nutrients and TOC at Reference Bay site REFW compared to Roberts Bay sites is likely a consequence of the bottom topography of Reference Bay and does not necessarily indicate that there are reduced levels of algal growth at this site. There is likely a higher degree of vertical mixing occurring at Reference Bay as tidal flushing forces water through a constriction and over a shallow sill during flood and ebb tides. Enhanced vertical mixing would allow for the replenishment of surface nutrients by nutrient-rich bottom waters.

Similar to nutrient profiles, concentrations of total and dissolved metals in the water column tended to be similar among sites in Roberts and Reference bays. Average concentrations of total arsenic and total cadmium across all sites and depths were 0.00091 mg/L and 0.000054 mg/L, respectively (Figure 3.5-4). Concentrations of iron and manganese were slightly lower in the surface compared to deep waters (Figures 3.5-6), indicative of algal uptake of these micronutrients. Dissolved iron was below detection limits (<0.005 mg/L) at all sites and depths, while total iron averaged 0.009 mg/L in Roberts and Reference bay samples collected from >25 m depth, indicating that the bottom water iron pool consisted of particulate iron. With some exceptions, total and dissolved chromium (Figure 3.5-5), mercury (Figure 3.5-7), and zinc (Figure 3.5-8) concentrations tended to be below their respective detection limits (<0.05, <0.00001, and <0.005 mg/L). Site WT0 in the shallow, southeastern basin of Roberts Bay tended to have the highest concentrations of total copper (0.00058 mg/L; Figure 3.5-5), manganese (0.0017 mg/L; Figure 3.5-6), nickel (0.00062 mg/L; Appendix 3.5-1), and zinc (0.00059 mg/L; Figure 3.5-8).

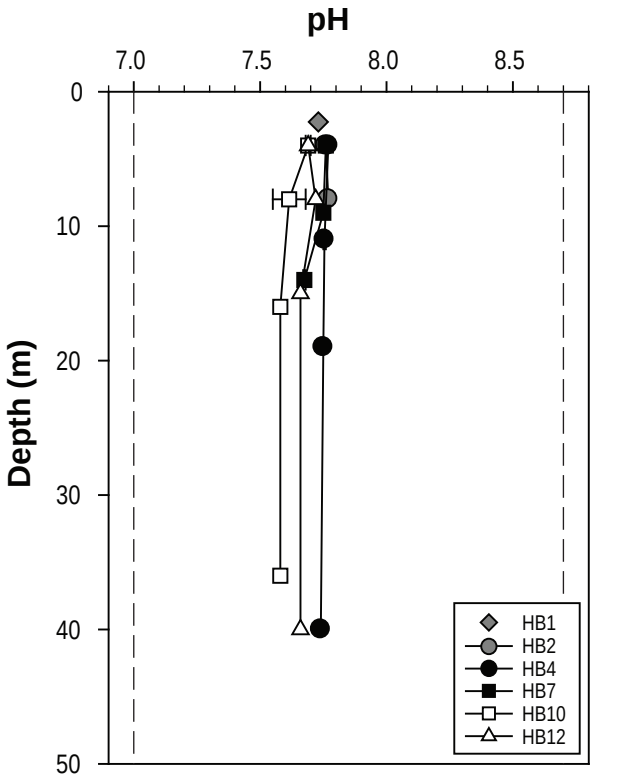
3.5.1.2 Hope Bay

Winter water quality samples were collected from six sites in Hope Bay (HB1, HB2, HB4, HB7, HB10, and HB12) on May 3, 2009. Under-ice surface samples were collected at all sites, and at the deeper sites, samples were collected from above and below the pycnocline. Profiles of water quality parameters are shown in Figures 3.5-9 to 3.5-16, and all water quality data and realized detection limits are presented in Appendix 3.5-1.

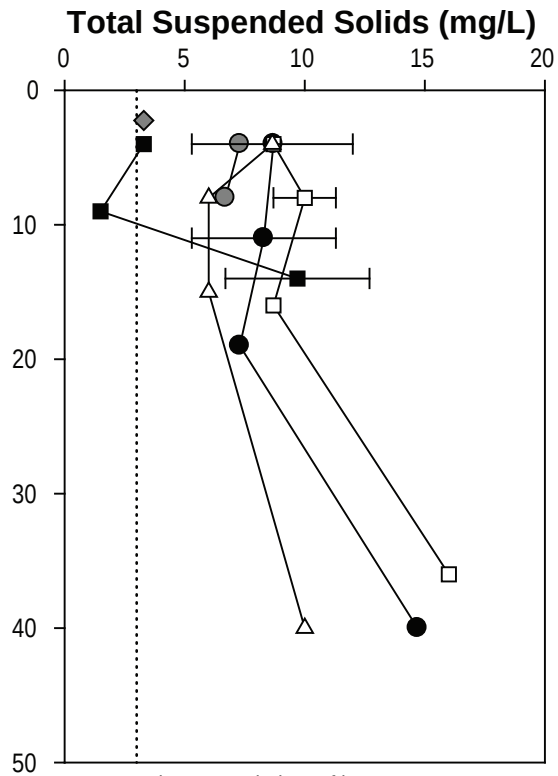
There were no apparent spatial trends in physical parameters among Hope Bay sites. Winter pH levels ranged from 7.58 in the deep waters of HB10 to 7.77 above the pycnocline at both HB2 and HB4 (Figure 3.5-9). TSS levels in Hope Bay sites were generally similar to levels in Roberts and Reference bays (with the exception of Roberts Bay site WT0), ranging from below detection limits (<3 mg/L) at HB7 at 9-m depth to 16 mg/L at HB10 at 36-m depth (Figure 3.5-9). Turbidity levels were low at most sites (<0.4 NTU), but were slightly elevated at HB1 (0.74 NTU) and HB12 (1.2 NTU; Figure 3.5-9).

Nutrient levels were generally similar among sites in Hope Bay, and slight vertical concentration gradients were apparent for some nutrients (Figures 3.5-10 and 3.5-11). Total phosphorus concentrations ranged from 0.027 mg/L at HB12 (15-m depth) to 0.045 mg/L at HB1 (2-m depth), and orthophosphate made up the majority of the total phosphorus pool (Figure 3.5-11). There was a slight decrease in surface orthophosphate levels compared to deeper waters, but the same vertical trend was not apparent for total phosphorus. Nitrate concentrations above the pycnocline ranged from 0.051 mg/L at HB1 to 0.067 at HB10, and reached a maximum of 0.088 mg/L below the pycnocline at site HB4. Surface nitrate concentrations were consistently lower than bottom water concentrations at all Hope Bay sites (Figure 3.5-10). Ammonia and nitrite levels were usually below their respective detection limits (<0.005 and <0.002 mg/L; Figure 3.5-10 and Appendix 3.5-1). Silicate concentrations at the surface ranged from 1.3 mg/L at HB1 to 1.4 at HB12, and reached a maximum of 2.0 mg/L below the pycnocline at site HB4 (Figure 3.5-10). Similar to nitrate and orthophosphate, silicate levels were consistently lower at the surface than at depth. TOC concentrations ranged from 0.68 mg/L at HB4 at 19-m depth to 1.0 mg/L at HB2 at 8-m depth (Figure 3.5-11). Surface concentrations of TOC tended to be slightly higher than bottom water concentrations. As observed in Roberts and Reference bays, the vertical gradients in Hope Bay sites characterized by higher TOC and lower nutrients at the surface than at depth indicate that algal growth was occurring during the winter sampling period.

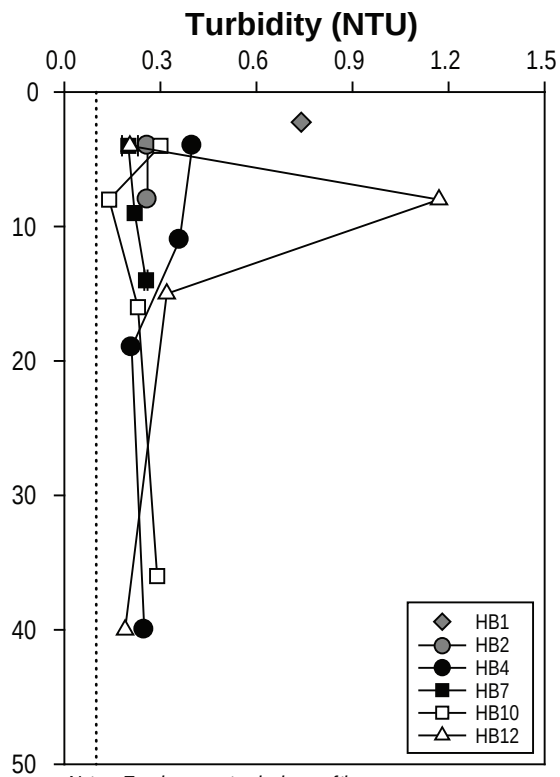
Concentrations of total and dissolved metals in the water column tended to be similar among sites in Hope Bay. For certain metals, site HB1 at the head of Hope Bay was an exception to this trend, as it contained higher surface concentrations of manganese (0.0016 mg/L; Figure 3.5-14) and total zinc (0.0020 mg/L; Figure 3.5-16) than other sites surveyed. Manganese was the only metal that displayed a vertical gradient, with surface concentrations averaging 0.0010 mg/L and bottom concentrations averaging 0.0018 mg/L, suggesting algal uptake of this trace metal. Average concentrations of total arsenic and total cadmium across all sites and depths were 0.0010 mg/L and 0.000053 mg/L, respectively (Figure 3.5-12), which are similar to levels in Roberts and Reference bays. Compared to Roberts and Reference bays where chromium concentrations were always below detection limits, chromium levels were naturally elevated at Hope Bay sites, averaging 0.066 mg/L across all sites and depths and reaching a maximum of 0.082 mg/L at HB12 (Figure 3.5-13). Mercury concentrations were always below detection (<0.00001 mg/L) at Hope Bay sites (Figure 3.5-15).



Notes: Error bars are standard error of the mean.
Analytical detection limit = 0.1 pH units.
Dashed lines represent CCME water quality guideline (pH 7.0–8.7).



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (3 mg/L).
CCME guideline: maximum increase of 25 mg/L from background levels for short-term exposure, and maximum average increase of 5 mg/L from background levels for longer-term exposure.



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.1 mg/L).
CCME guideline: maximum increase of 8 NTU from background levels for short-term exposure, and maximum average increase of 2 NTU from backgound levels for longer-term exposure.

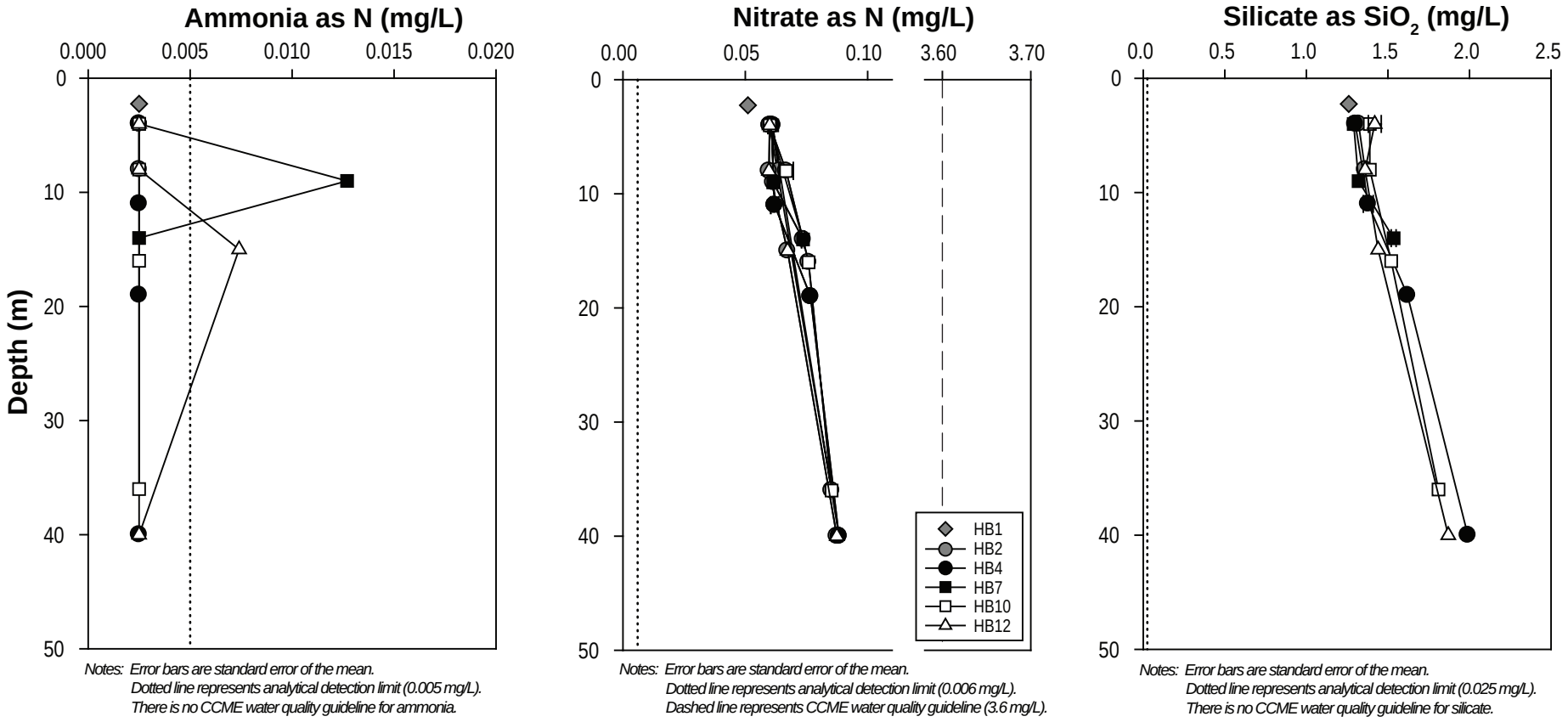
Figure 3.5-9

NEWMONT NORTH AMERICA

pH, Total Suspended Solids, and Turbidity in Hope Bay, Hope Bay Belt Project, May 2009

Figure 3.5-9

Rescan™ Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.005 mg/L).
There is no CCME water quality guideline for ammonia.

Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.006 mg/L).
Dashed line represents CCME water quality guideline (3.6 mg/L).

Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.025 mg/L).
There is no CCME water quality guideline for silicate.

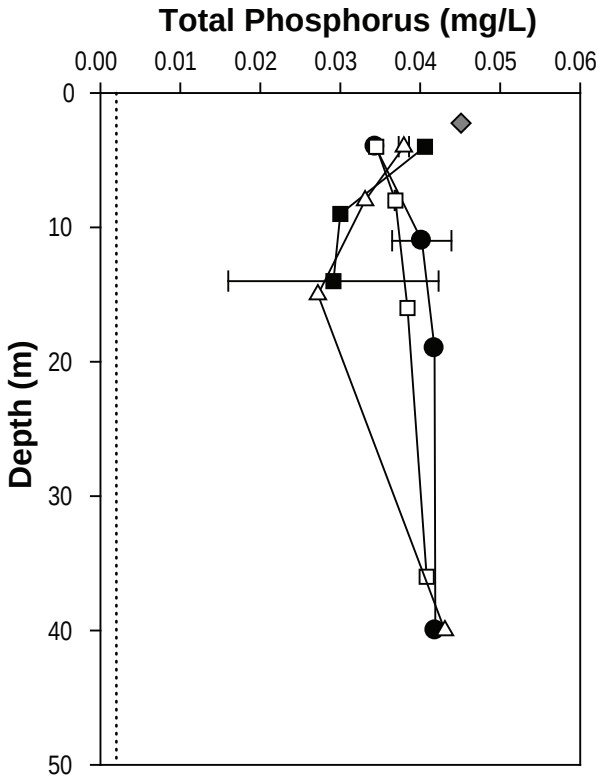
Figure 3.5-10

NEWMONT NORTH AMERICA

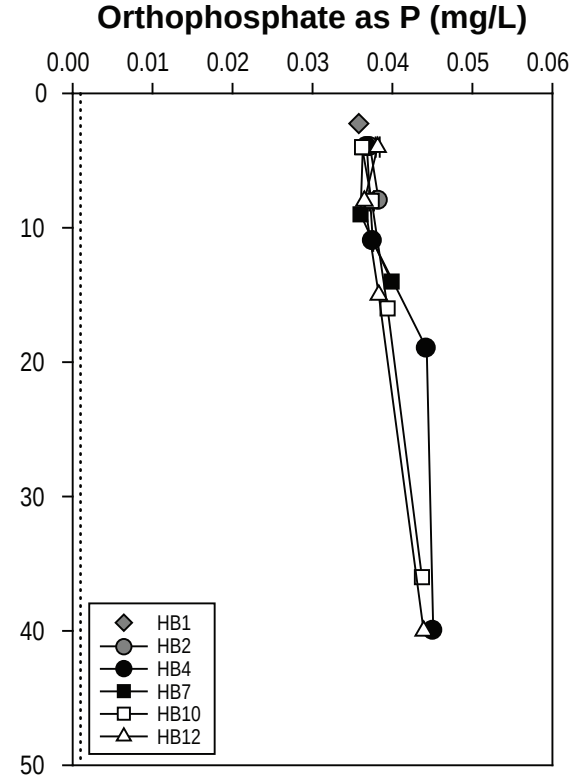
Ammonia, Nitrate, and Silicate Concentrations in Hope Bay, Hope Bay Belt Project, May 2009

Figure 3.5-10

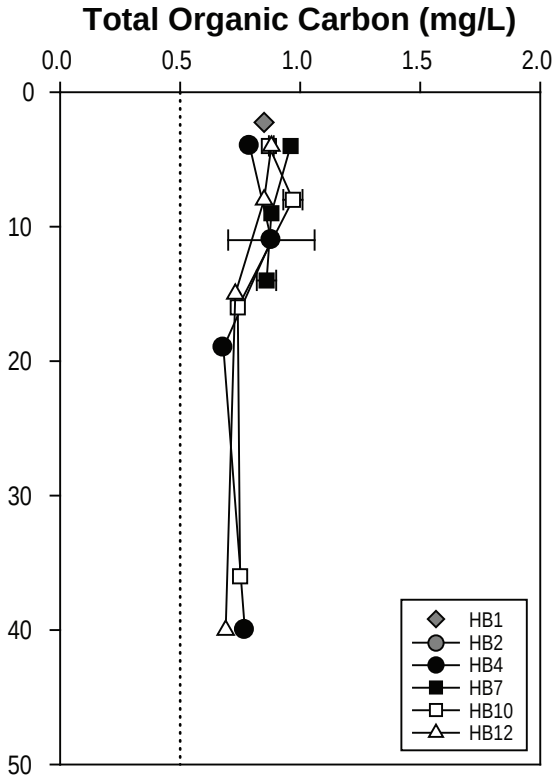
Rescan™ Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.002 mg/L).
There is no CCME water quality guideline for total phosphorus.



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.001 mg/L).
There is no CCME water quality guideline for total orthophosphate.



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.5 mg/L).
There is no CCME water quality guideline for total organic carbon.

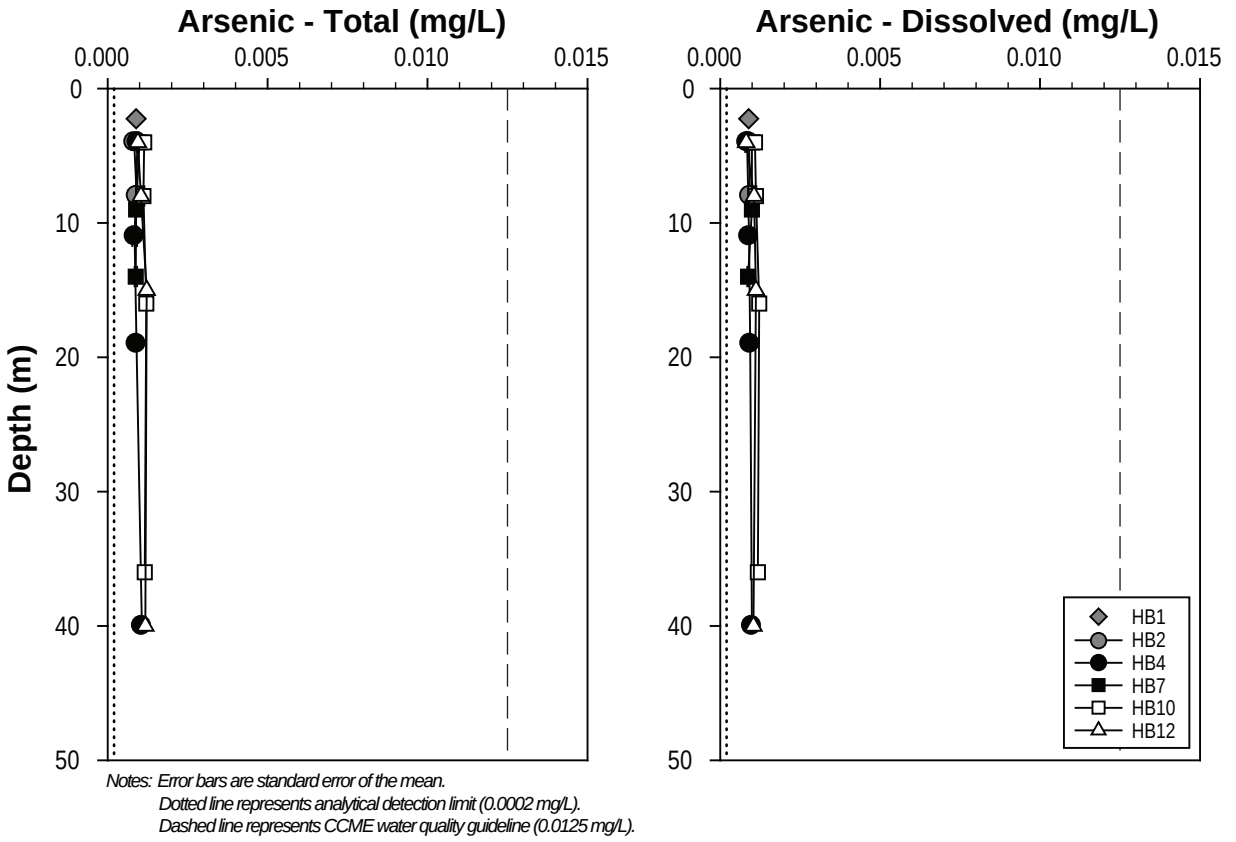
Figure 3.5-11

NEWMONT NORTH AMERICA

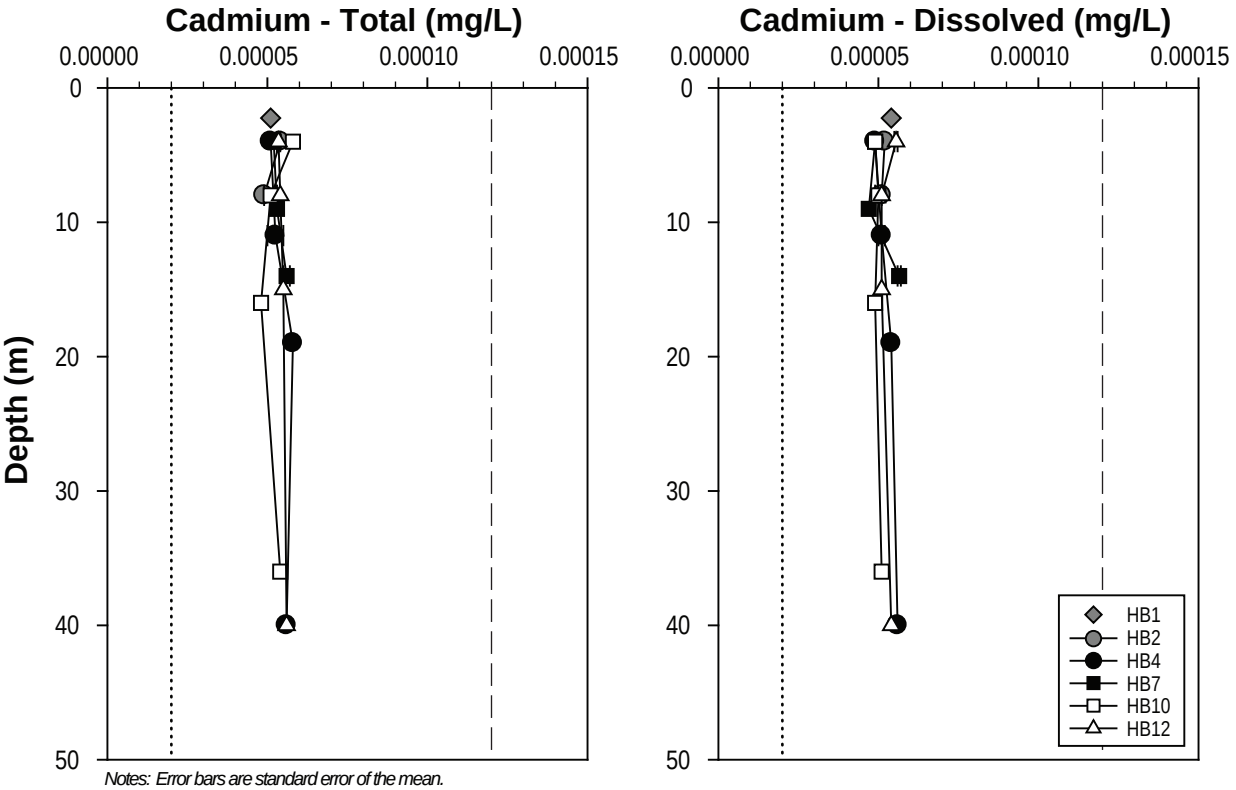
Total Phosphorus, Orthophosphate, and Total Organic Carbon Concentrations in Hope Bay, Hope Bay Belt Project, May 2009

Figure 3.5-11

Rescan™ Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.0002 mg/L).
Dashed line represents CCME water quality guideline (0.0125 mg/L).



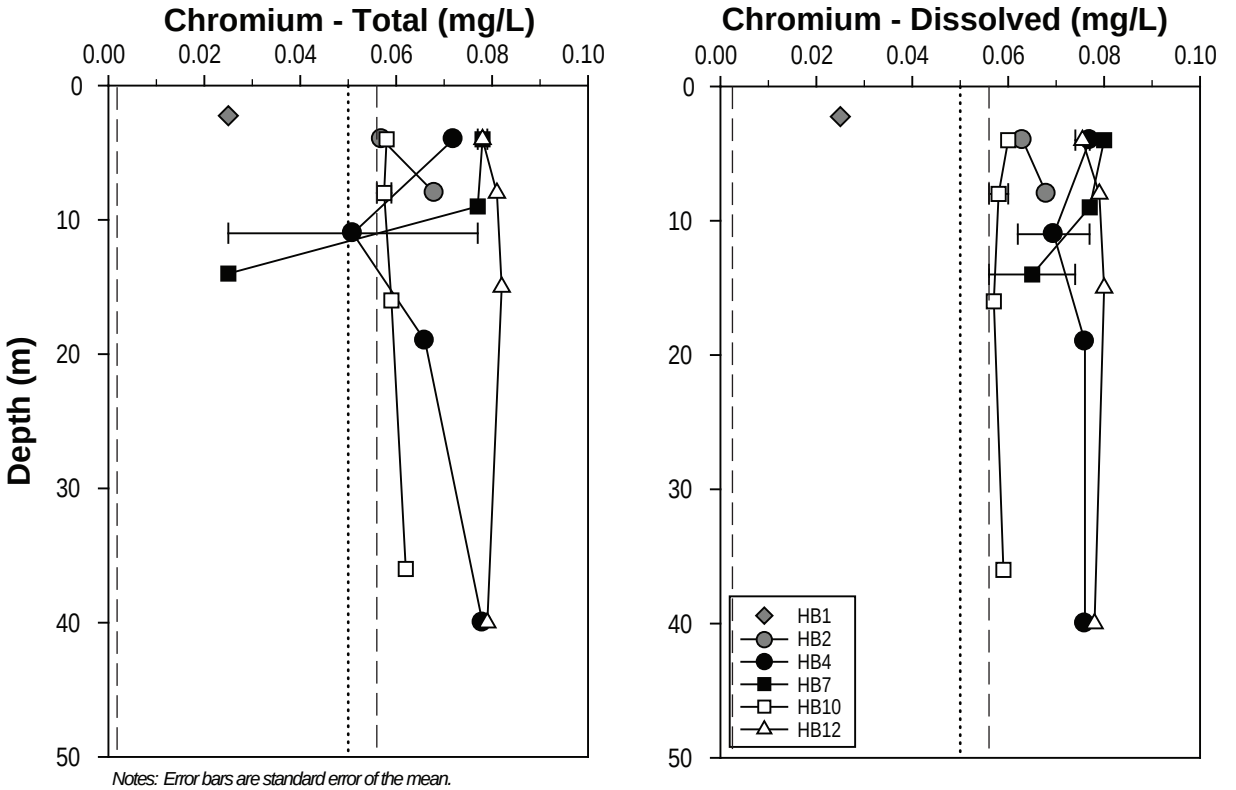
Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.00002 mg/L).
Dashed line represents CCME water quality guideline (0.00012 mg/L).

NEWMONT NORTH AMERICA

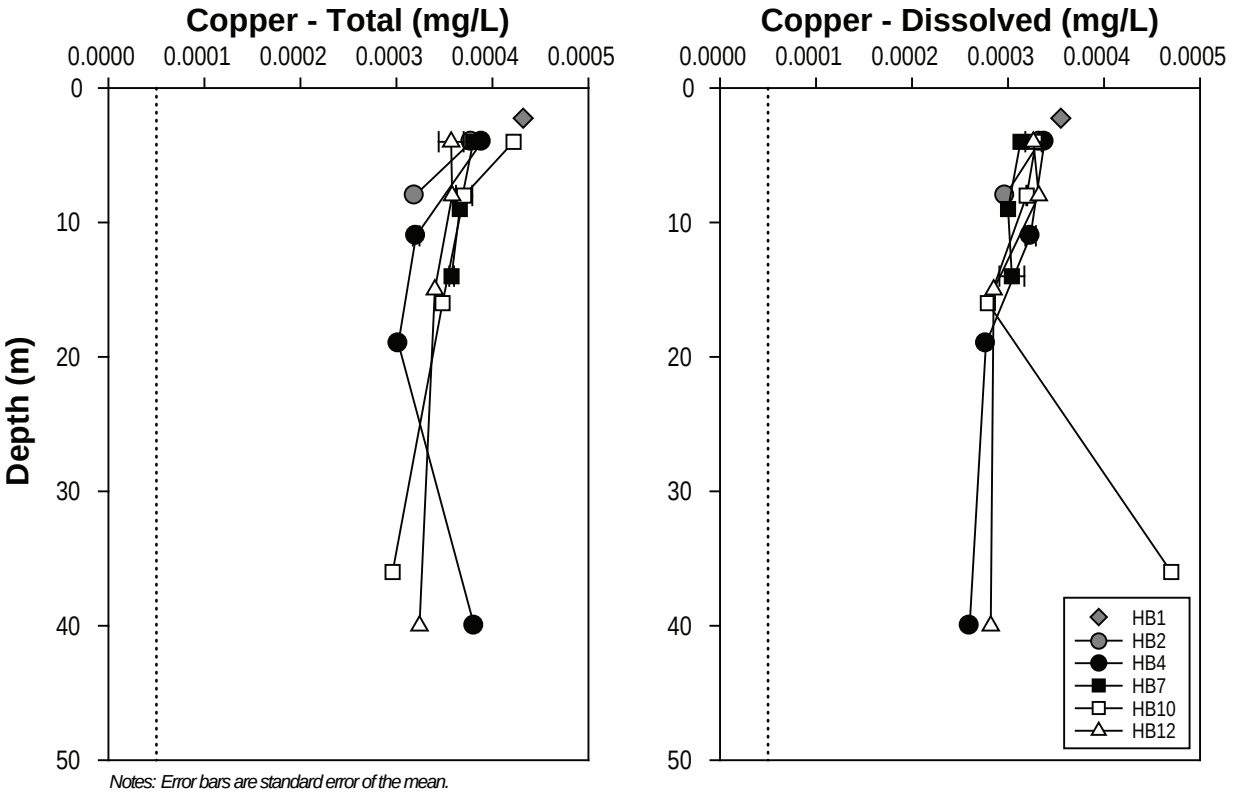
Arsenic and Cadmium Concentrations in Hope Bay, Hope Bay Belt Project, May 2009

Figure 3.5-12

Rescan™ Engineers & Scientists



Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.05 mg/L).
Dashed lines represents CCME water quality guideline of 0.056 mg/L for Cr(III) and 0.0015 mg/L for Cr (VI).



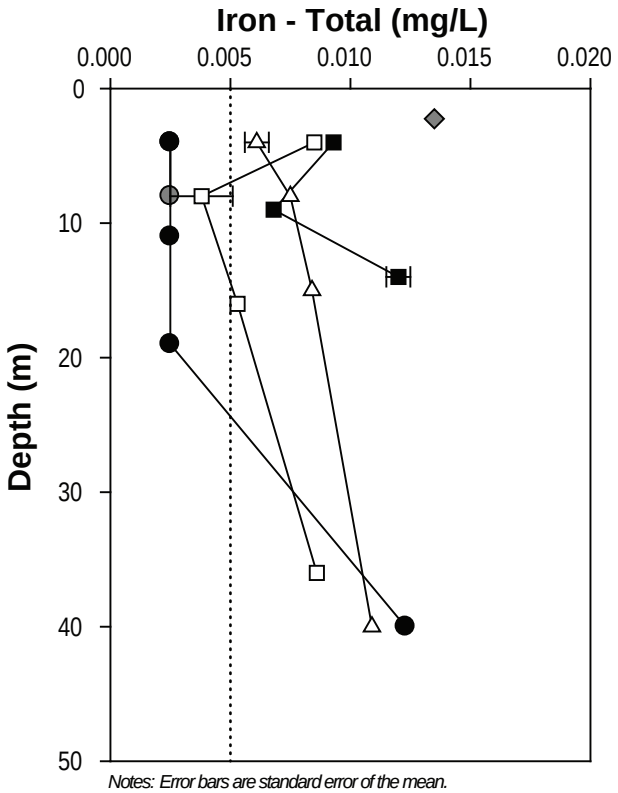
Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.00005 mg/L).
There is no CCME water quality guideline for copper.

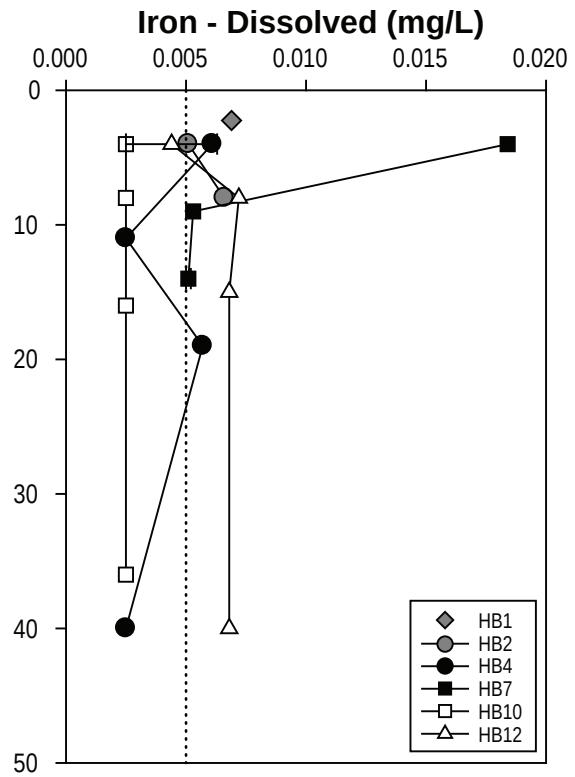
NEWMONT NORTH AMERICA

Chromium and Copper Concentrations in Hope Bay, Hope Bay Belt Project, May 2009

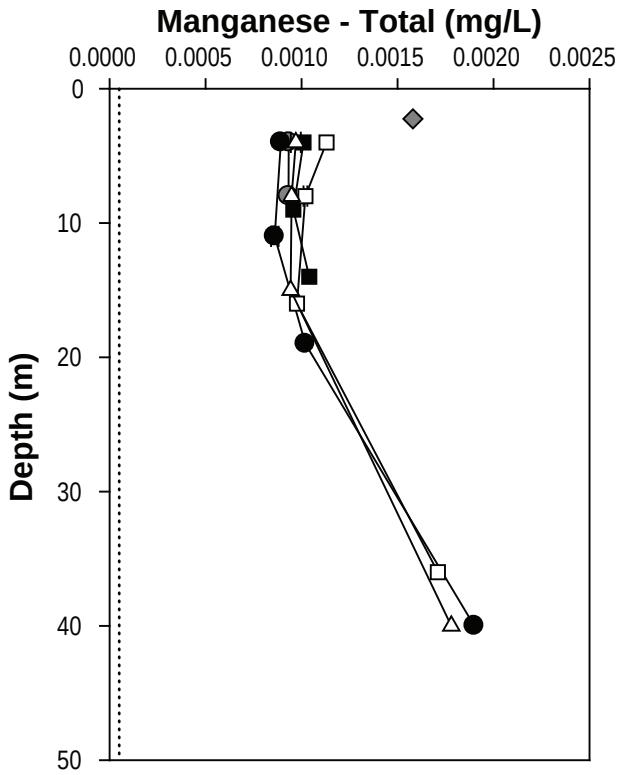
Figure 3.5-13

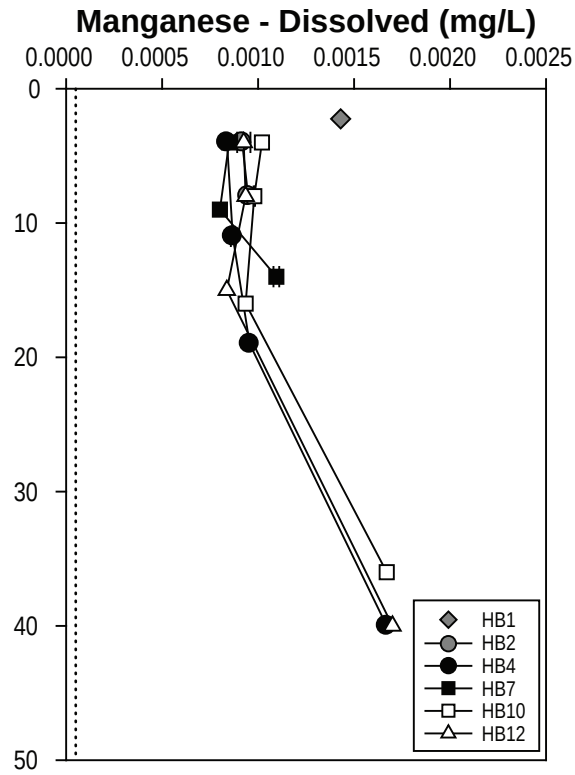
Rescan Engineers & Scientists





Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.005 mg/L).
There is no CCME water quality guideline for iron.





Notes: Error bars are standard error of the mean.
Dotted line represents analytical detection limit (0.00005 mg/L).
There is no CCME water quality guuideline for manganese.

NEWMONT NORTH AMERICA

Iron and Manganese Concentrations in Hope Bay, Hope Bay Belt Project, May 2009

Figure 3.5-14

Rescan Engineers & Scientists